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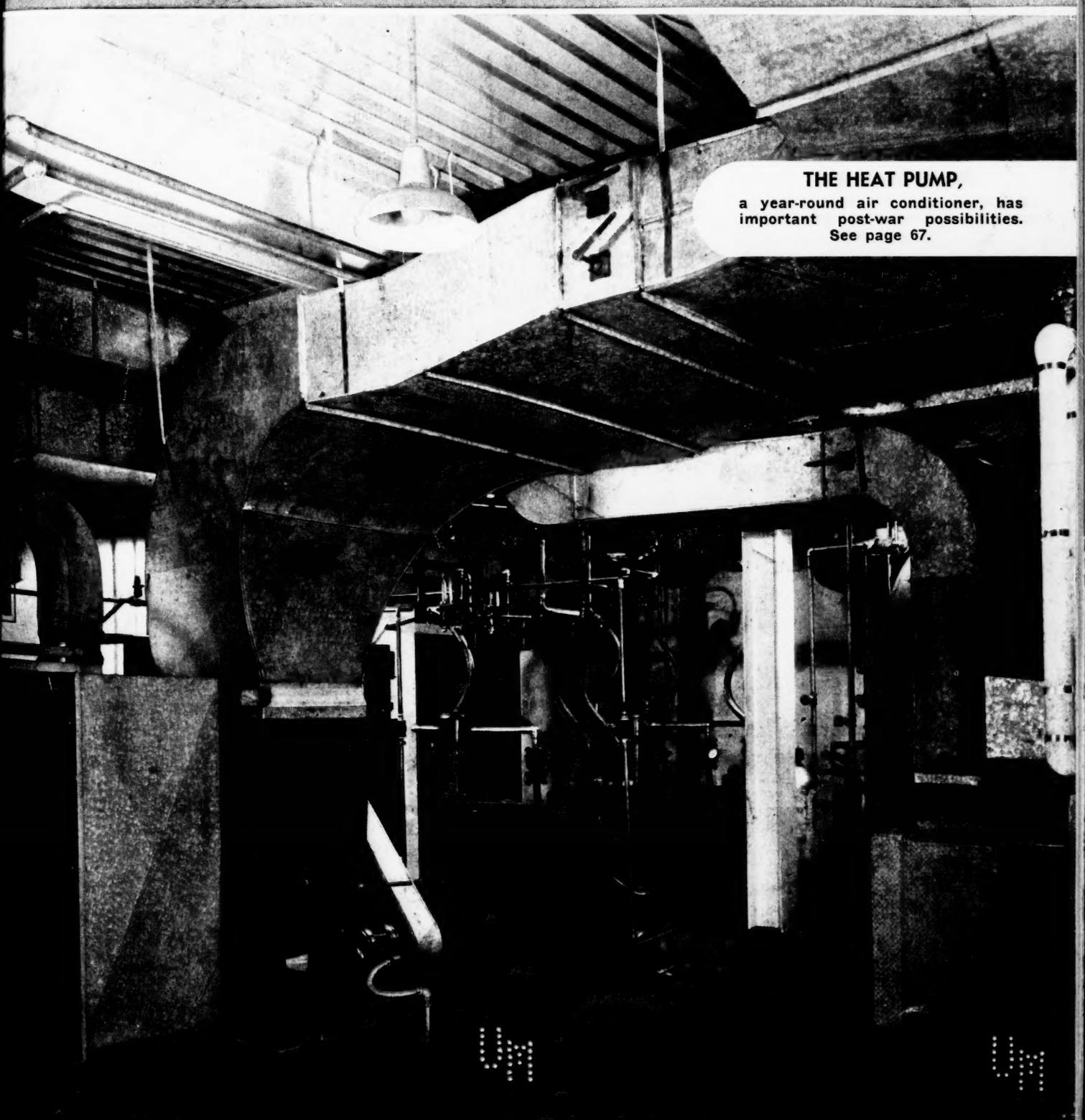
HEATING AND VENTILATING

JAN 25 1944

MMERCIAL, INDUSTRIAL AND INSTITUTIONAL AIR CONDITIONING, REFRIGERATION, PIPING, HEATING, VENTILATION



THE HEAT PUMP,

a year-round air conditioner, has important post-war possibilities.
See page 67.

Another building owner who got

more heat with less fuel

"Our first floor tenants complained of the heat . . . Our top floor tenants complained of the cold . . . So we decided to do the only sensible thing. And here's what the heating expert we consulted told us:

"'Stop wasting valuable fuel! Convert your obsolete steam heating system into an economical and *controllable* Webster System—one that assures prompt heating-up, balanced distribution of steam, and even room temperature throughout the building. That's the only way you can get better heat distribution with the amount of fuel allotted you.'"

With the Webster Moderator System of Steam Heating, waste of valuable fuel through overheating is minimized. The Webster "Control-by-the-Weather" System automatically changes the heating rate to agree with changes in outdoor temperatures.

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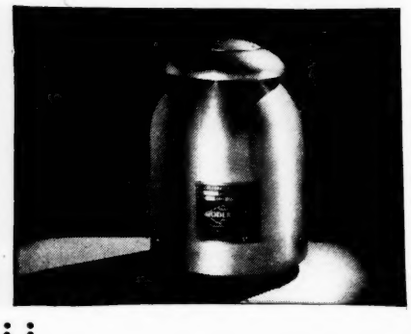
If you are wondering how to obtain the same comfortable heating service in your building with less fuel this winter, write for "Performance Facts" and compare the performance information on the Webster Moderator System of Steam Heating. This free book contains case studies of 268 modern steam heating installations.



The Webster Outdoor Thermostat automatically changes heating rate when outdoor temperature changes. This device is part of the Webster Moderator System, a central heat control that is saving fuel for hundreds of America's commercial and institutional buildings.

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ARMY E NAVY

Making Boosters for U.S. Army Ordnance

Webster Steam Heating

A MONTHLY
MAGAZINE FOR ENGINEERS
AND CONTRACTORS CONCERNED WITH
COMMERCIAL, INDUSTRIAL AND INSTITUTIONAL AIR CONDITIONING, REFRIGERATION, PIPING, HEATING, VENTILATION

HEATING AND VENTILATING

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ROBERT B. LUCHARS

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Editorial Staff

Editor
CLIFFORD STROCK

Associate Editor
N. N. WOLPERT

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Advertising Representatives

Eastern Representative
HARRY J. TWINE
148 Lafayette Street
New York 13, N. Y.

Western Representative
GEORGE G. TURNER
228 North La Salle Street
Chicago 1, Ill.

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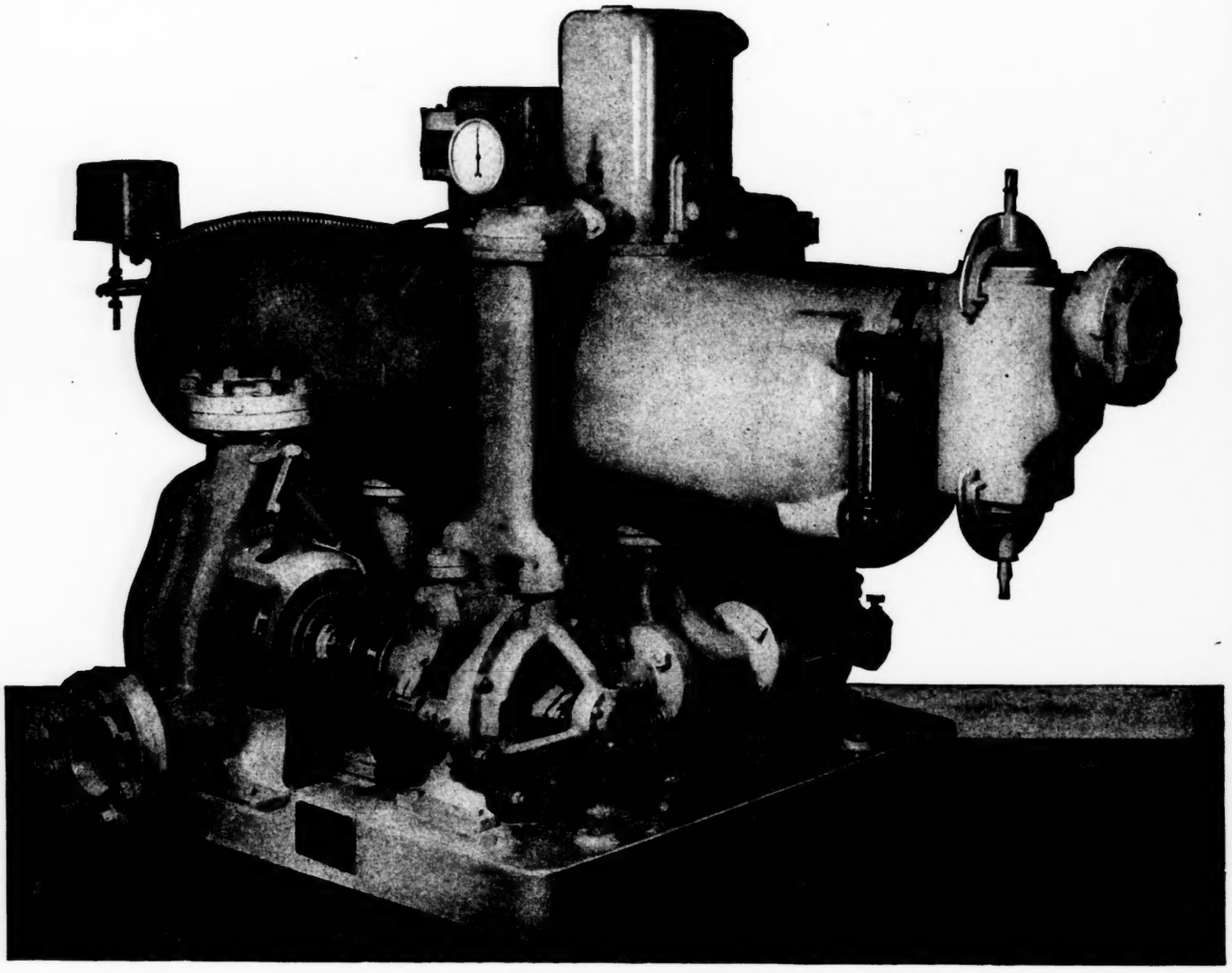
Next Month's Issue

Summer and year-round air conditioning with gas will be the subject of the February "Blueprint of Post-War Realities" ... Also in February, the air conditioning of a precision manufacturing plant ... irradiation as a health factor ... radiant heating of a naval chapel ... heating problems in a state college

Where building heat *MUST NOT FAIL* always specify the Nash Vapor Turbine



THIS SAFE NASH HEATING PUMP DOES NOT REQUIRE ELECTRIC CURRENT BECAUSE IT OPERATES ON THE SAME STEAM THAT HEATS THE SYSTEM

In Hospitals, Greenhouses, Schools, Public Buildings, Theatres, wherever heating systems must not fail, install the Nash Vapor Turbine, for it is entirely independent of electric current failure, and continues to operate as long as there is steam in the system.

More than that, the Vapor Turbine is a most economical pump, for the elimination of electric current does away with current cost, the largest single item in the operation of an ordinary return line heating pump.

Greater savings still are effected by the Vapor Turbine in the system, for the reason that this pump operates continuously. It is the only pump that can do this with economy. Continuous operation means uniform circulation, and uniform circulation saves steam.

The Nash Vapor Turbine has but one moving part, rotating in the casing without metallic contact, and requiring no internal lubrication. Quiet, compact, and trouble-proof. Bulletin A-290 is free on request.

THE NASH ENGINEERING COMPANY

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REFRIGERATION SPEEDS SHRINK FIT ASSEMBLY

HEATING AND VENTILATING

FRED W. WHITCOMB with ALFRED C. HOUSER

Shrinking a plug into an airplane landing gear part. This method replaces an arbor press and eliminates cocking and scoring, the cause for costly rejections. The strut is heated to 212F. Tolerances are sufficient for an easy hand fit.

UNDER the stimulus of war, heat has gone into reverse gear. Cold, or heat in reverse, is performing many functions, with new ones popping up every day.

Since absolute zero, or the total absence of all heat, is 459.7 degrees below zero Fahrenheit, then any temperature above that point is heat. And so extreme low temperature refrigeration comes within the province of the heating engineer.

Shrink fit assemblies, one application of extreme low temperatures, has found a widespread and enthusiastic acceptance in industry. Here low temperature performs the function of a machine tool, frequently replacing powerful hydraulic press equipment. The human hand is able to slip a part in place easily, which previously required tons of pressure. Practical results are measured in increased production, lowered manufacturing costs, and an improved end product. Stimulated by the demand for war material, more and more manufacturers are adopting shrink fitting as standard practice. They find it provides a simple, fast method of assembling parts.

The use of mechanical refrigeration for shrink fit chilling is of relatively recent origin. The first successful operations of this kind were accomplished by shrinking with liquid nitrogen having a temperature of —320.4F; with liquid air at —297.4F; and with solidified CO_2, commonly known as dry ice, at —109.6F. It is not possible to secure working temperatures from dry ice lower than —90F because of the necessity of using it in an immersion bath such as kerosene or methylene chloride. Under such conditions the floating particles of dry ice surround themselves with a blanket of carbon dioxide gas, constituting an effective insulation.

Liquid nitrogen and liquid air are expensive, difficult to handle, and in the case of liquid air, sometimes dangerous. Nevertheless, urgency of production and the better results obtained warranted the risk.

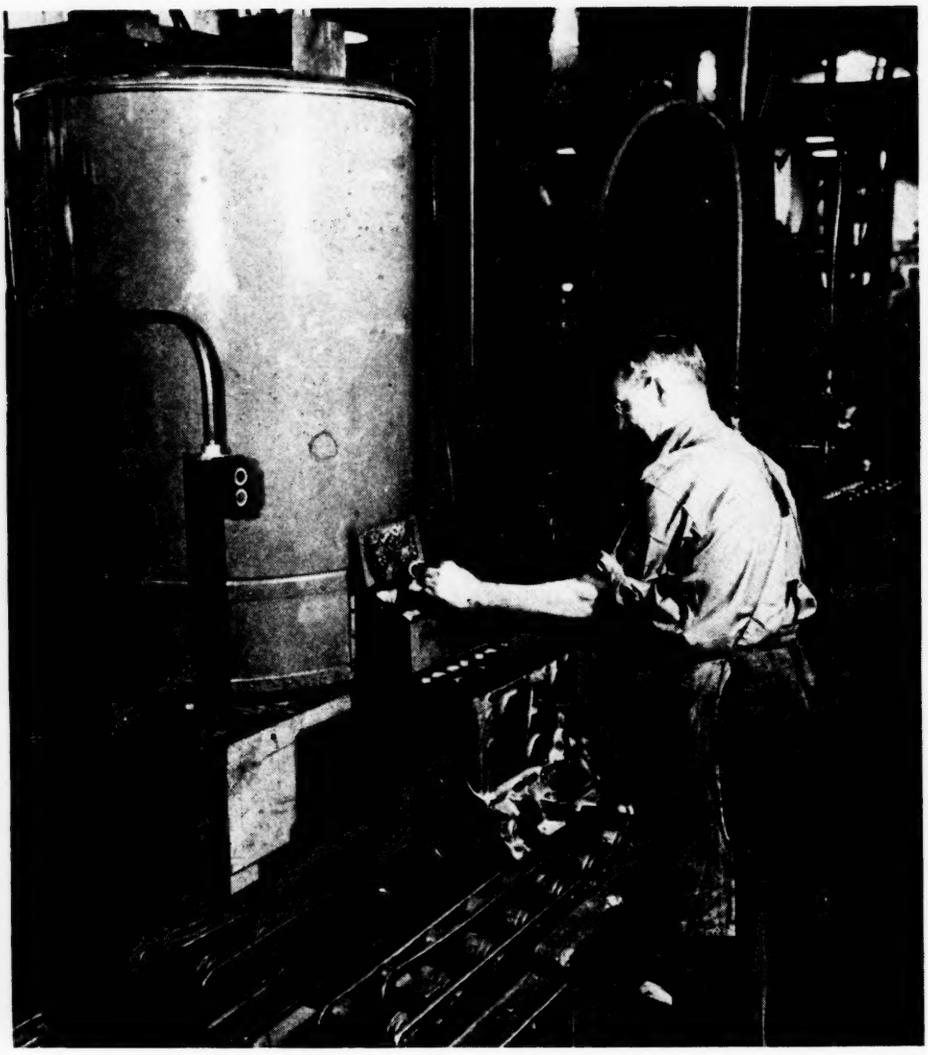
It was not until mechanical substitutes able to produce temperatures below —100F made their appearance on the market, that these chilling gases were abandoned. One chilling unit now available provides the heat absorbing equivalent of eight pounds of dry ice per hour at —120F. Such machines are employed for shrink fitting by many of America's most important manufacturing and automotive organizations.

How Shrink Fitting is Done

Shrink fitting ordinarily involves the chilling of the inserted part only, although in some cases, especially where the diameter of the male part is very small, heating of the matching part is also practiced.

Shrink fitting has distinct advantages over drive fitting, because the male piece is usually a round or square part and of some given length. Driving a male part into the female member can cause the following conditions:

1. Mechanical strains within the male piece.
2. Bending or springing of the male piece.
3. "Fatigue" at the juncture of the male piece and female member.
4. Rupture of the female member.



Unit at left shrinks inserts so that they will drop into the motor cylinder block. Tight fit is obtained when the inserts return to room temperature.

Advantages of shrink fit over press fitting are:

1. No mechanical strains within the male piece.
2. No bending or warping of male piece.
3. No "cocking" of male piece causing a poor rest, or scoring of the walls of the female member.

In the process of shrink fitting two parts together, it is well to remember the following basic rules:

1. Hold to the same tolerances (or closer) on both the male and female pieces as previously practiced when the assembly of these parts was accomplished by press or drive fitting.
2. If the male part has extremely thin walls (as in a tube), it is advisable to make up a plug that will fit inside of the male part. By inserting this plug into the male part and then freezing both pieces at the same time, it will be found that the male part (and plug) will not return to its original size too quickly before it is inserted all of the way "home" into the matching piece, as might be the case if only the male part was frozen and inserted into the female part. The plug adds to the volume of the male piece, which is highly desirable, because of the extremely thin walls of the male piece. Care should be taken, however, to make this plug to the correct size (a few thousandths smaller) so that it can be removed after the male part has positioned itself.
3. If sufficient shrink cannot be achieved on the male piece because of small diameter, it is a common practice to heat the female piece, causing it to expand. This combination of heat and cold is used in many plants with excellent results. However, if the female part is heated, care should be taken that the heat intensity is not great enough to cause warping. Usually 212F is warm enough to cause the necessary expansion without danger of warping.

If the female part is of such size that it would be inconvenient to heat the unit all over, the plug type induction heater is recommended. This type of heater only heats the hole and the immediate area surrounding same.

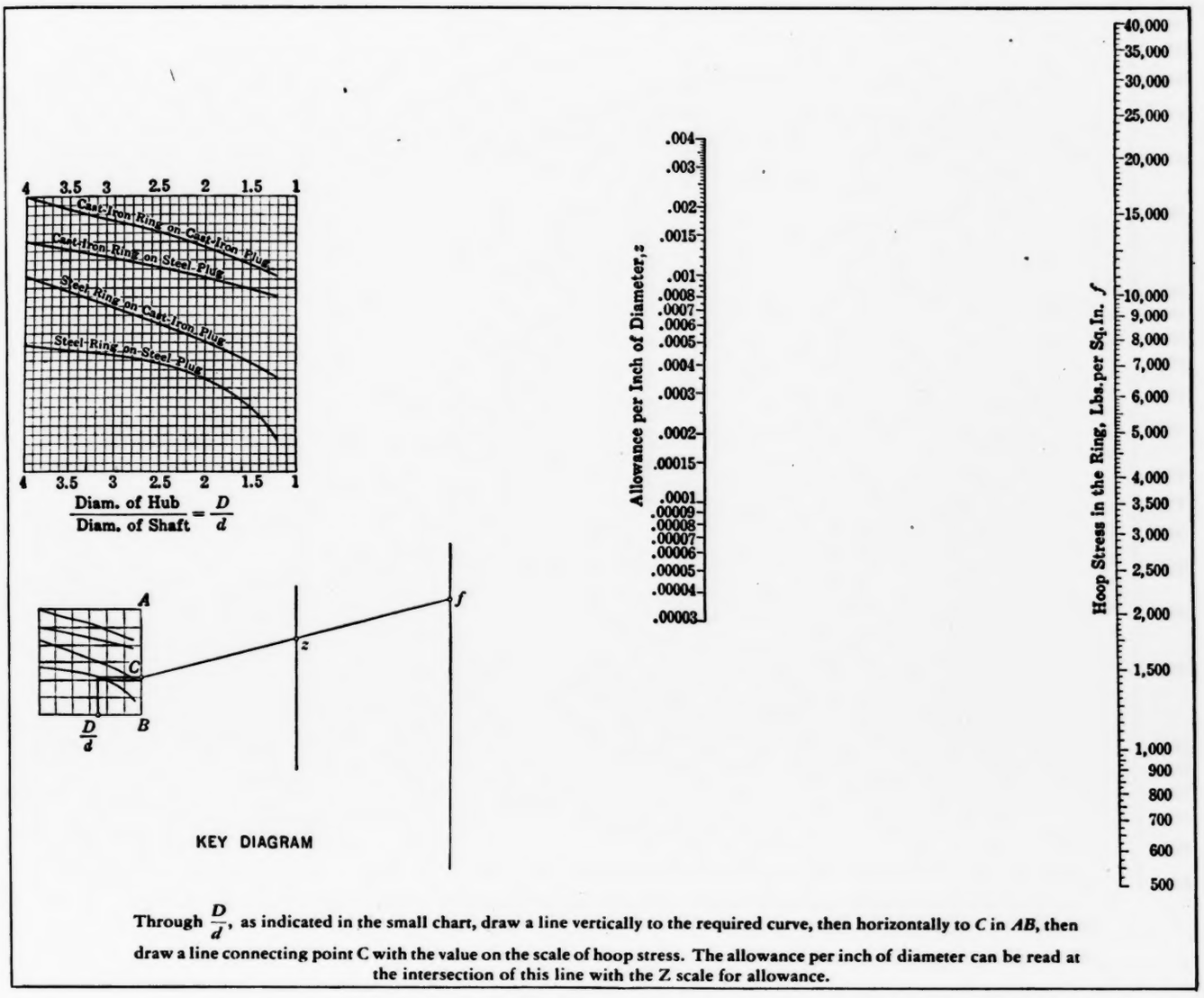
Table 1 shows the amount of shrinkage of both ferrous and non-ferrous metals at —60F and at —120F.

Hence, a 6-in diameter bearing if frozen to —60F would shrink (6 x .0008) or .0048-in. The same bearing frozen to —120F would shrink (6 x .0013) or .0078-in. Noting the difference in the shrinkage of a 6-in diameter bearing from 70F to —60F and 70F to —120F which is .003, one must realize that the smaller the diamater of the part to be shrunk, the greater must be the cold intensity, in order to make a satisfactory shrink fit.

The question of how long a part must remain in the cold to obtain its maximum amount of shrink can best be answered as follows:

TABLE 1.—SHRINKAGE PER ONE-INCH DIAMETER

	From 70F to —60F	From 70F to —120F
Tool Steel (steels)	.0008	.0013
Phosphor Bronze	.0012	.0018
Aluminum Bronze	.0012	.0018
Brass	.0014	.002
Aluminum	.0017	.0023
Magnesium	.0017	.00235



Through $\frac{D}{d}$, as indicated in the small chart, draw a line vertically to the required curve, then horizontally to *C* in *AB*, then draw a line connecting point C with the value on the scale of hoop stress. The allowance per inch of diameter can be read at the intersection of this line with the Z scale for allowance.

—From "Handbook for Machine Designers, Shop Men and Draftsmen," by Frederick A. Halsey, published by McGraw-Hill.

Charts for determining the amount of allowance for proper shrink fit assembly.

1.—Ascertain the Btu absorption capacity of the medium you are using per hour.

2.—Multiply the weight of material to be chilled by the temperature change (room temperature plus low point of chilling medium).

3.—Multiply this answer by the specific heat of article to be chilled (from Table 2)—this answer will give you the total Btu in load.

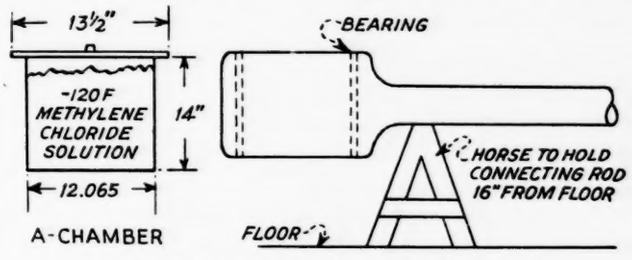
4.—Divide the Btu removal capacity of the medium you are using (from 1) into total Btu in load (from 4) which will give you the length of time parts must be immersed in the cold medium.

As stated before, many applications of shrink fitting are being used in war production today. A few are listed but names of companies must be omitted because of war work.

TABLE 2.—SPECIFIC HEAT OF COMMON MATERIALS

Aluminum	.212	Rubber, hard	.339
Brass	.092	Silver	.056
Bronze	.104	Steel	.118
Cast Iron	.113	Tantalum	.033
Copper	.092	Tin	.054
Glass	.180	Tungsten	.034
Marble	.206	Zinc	.093
Nickel	.109		

Source of information for Specific Heat, "The Engineers' Manual" by Ralph G. Hudson.



Removing the bearing—Problem 1.

PROBLEM No. 1.—SHRINKING BRONZE BEARING INTO AND OUT OF DIESEL ENGINE CONNECTING ROD.

Bearing size: 14-in. O.D.—12-in. I.D.—14-in. long

Tolerances held: +.004 to —.000

From Table 1 we found that we could shrink the

A diesel engine manufacturer shrinks piston pin bushings into position.

bearing .0018 per inch of diameter or a total of .0252-in. which was considerably more than we needed. Hence the time element was cut to five minutes, which even then gave us a shrink of .010-in. This proved highly successful, and eliminated the press.

There then remained the problem of removing the bearing. This was accomplished as follows:

The connecting rod was laid on its side, 16-in. from the floor, so that the face of the bearing was down. A chamber was made of sheet steel (A) that was .035-in. smaller than the I.D. of bearing. This chamber has a top and bottom plate electrically welded to the walls. The top was equipped with a screw plug. The chamber was filled with a solution of methylene chloride (which had been previously chilled to —120F) and placed within the walls of the bearing. Within four minutes the bearing fell to the floor.

PROBLEM NO. 2.—SPLINE SHAFT WITH A BEVEL GEAR.

Fifty-ton press formerly used.

Tolerance held +002 to —001

Size of spline, 1.750

Spline is subjected to —120F; shrink noted .00275-in.

Hand operated arbor press now used.

Results: Time saved; no fatigue, cracking or strains.

PROBLEM NO. 3.—VALVE GUIDES (ALUMINUM) INTO AIRCRAFT ENGINE.

Former procedure: Heat engine section, then press guide into place.

New procedure: Induction heat valve guide holes; chill valve guides to —120F. Tap lightly into position.

New results: Considerable time saved by not heating entire part. No press needed. No strains or scoring of female parts.

PROBLEM NO. 4—CAST IRON CYLINDER LINER INTO PORTABLE GAS ENGINE (ALUMINUM BODY).

Former procedure: Body heated to 400F and liner pressed into place. Heat caused warping of body. Liner not always seated tightly all around, causing blow-by.

New procedure: Body heated to 225 to 300F. Liner chilled to —120F and pressed into place.

Results: Perfect union. No blow-by, and no warping.

Post-War Probabilities

Qualified experts are unanimous that sub-zero shrink fitting will become standard practice in the manufacture of consumer goods after the victory has been won. Coupled with sub-zero heat treating of steel and other metals, designers of automobiles, typewriters, precision photographic equipment, washing machines and all the other mechanical devices which have typified the American standard of living, are certain to provide products of new beauty and superior quality at prices within the reach of all.

Test Chamber Duplicates Flying Conditions

A large high-altitude chamber of unique abilities has been created by Westinghouse engineers for testing motors, generators, and their controls, to learn how operation will change at high altitudes. In this chamber conditions of 70,000 ft can be readily obtained. Temperature can be lowered to —67F and pressure to ¾ lb per sq in., which is about 1/20 of sea-level pressure. Humidity can be controlled.

Identical stratosphere conditions are difficult to achieve because all air forced into the chamber under controlled temperature, pressure, and humidity is fresh air. None of the air can be recirculated, otherwise brush dust and gases from the insulation would accumulate to falsify test results. The refrigerant is a mixture of crushed dry ice and varsol.

Incoming air can also be heated and saturated with water, to simulate jungle conditions. In this way a complete flight cycle can be duplicated both as to atmosphere and time. Effects encountered in taking-off from a hot landing strip in a jungle, and climbing (at normal rate) to the cold, dry, rarefied air of the stratosphere can be reproduced.

Brush wear, creepage distances required for different voltages and ventilation need of aircraft electrical apparatus are among the problems being studied in the chamber. This laboratory, where all conditions are under rigid control, eliminates some of actual high-altitude flight testing which at best is expensive, time-consuming, and is quite difficult to control.

Industrial Construction to Boom

GEORGE A. BRYANT

President, The Austin Company, Cleveland, Ohio

The president of a very large company of engineers and builders gives facts to substantiate his claim that there will be considerable activity in the construction of commercial and industrial buildings during the post-war period. Some industries will move to more efficient buildings, new manufacturing processes will require special construction, large plants will be decentralized, and buildings will be relocated to cut distribution expenses and to increase service to customers.

THE outlook in the construction industry, particularly in the field of industrial plants and commercial buildings, is very favorable. Present indications point to even greater activity in this field than the average before the war.

It might be assumed that, because of the many plants constructed during the war, industry would be well supplied with manufacturing facilities of all types. However, a great many of the war plants are too large and unsuitable for the manufacture of consumer goods or other products for which there is a growing, unfilled demand. What is more important, a great many of them are not located where the industries now most in need of new or larger plants could make use of them.

Briefly, the factors that are stimulating industrial construction are as follows:

1. Few manufacturers have been able to expand or modernize their plants during the war period. Many established firms are becoming increasingly aware of the high costs and inefficiencies of operating in multi-story buildings, and are awaiting their first opportunity for removal to one-story buildings. In many instances, they are considering outlying sites. There is also a heavy backlog of demand for construction in many distribution and service industries, which have been unable to keep up with changing habits and shifting population trends.

2. The development of new manufacturing processes, many of which can best be served by plants of special character designed closely around the process, represents one distinct group of prospects. Included in this group are a number of new industries, some in the food and chemical fields, and others in the metals field.

3. Relocation is being considered by many industries as a means of cutting production costs, reducing distribution expense, and rendering more effective service to customers. The construction of plants at more advantageous sites is viewed by many as one of the most effective means of meeting competition. Firms that have prospered and grown to national importance in plants located where their founders set up shop anywhere from twenty-five to one hundred years ago are re-examining the economics of such locations in the face of growing competition and declining profit margins.

4. Decentralization of manufacturing operations is under way in many industries, for the same reasons that relocation is being considered. This is particularly true in consumer goods, automotive equipment, and other industries serving stable, national markets. It has long been the policy of container manufacturers, for instance, to locate small plants as close as possible to the industries that use their bulky products. While there are few exact parallels for this relationship between container manufacturers and canners or packers, the same principles apply in many industries.

5. The revamping of plants for more efficient operation and the conversion of many factories from special war production to peacetime operations will account for a large volume of construction activity. While certain of our war plants have been designed for special or single-purpose operations that have no exact parallel in normal times, the greatest part of America's war plant investment is in structures possessing basic flexibility, which renders them potentially useful for many types of manufacturing activity. The ultimate value of these buildings to industry hinges on the ability of engineers to adapt them for economic post-war uses.

The serious attention that industrial executives are giving to the basic economics affecting all their operations is the best indicator of things to come. Wartime experiences have opened their eyes to many inefficiencies. Nettled by their inability to match the performance of competitors on certain war contracts, some have discovered that they were over-departmentalized and are planning to improve their methods in new plants as soon as war restrictions are lifted.

For one organization which is contemplating extensive post-war expansion in various parts of the country, we have recently surveyed conditions in more than two hundred towns, distributed in half a dozen states, to find a single location. The approximate location of the prospective plant was de-

termined by the markets to be served, but the final selection of a site rested on basic population characteristics, and on taxes, water supply, power, transportation, etc.

It should be said that industry's viewpoint toward the character of its future plants is marked by the same thoroughgoing engineering approach exemplified in this search for a suitable location. Where new plants are needed, management will not be satisfied with buildings that do not offer the basic facilities for efficient production and a contented body of employes. Wartime experience has proved that man-power shortages and labor difficulties can be minimized by the right kind of working conditions.

The use of color in connection with safety, lighting, and for purely psychological reasons has received increasing attention. With industrial and office workers growing more and more conscious of the use of color in their homes and in all sorts of commercial establishments, it is only natural that color should be given consideration in the surroundings where the greatest proportion of their waking time is spent.

The availability of more economical air-conditioning, modern fluorescent lighting, and efficient insulation have a direct bearing on the outlook for future construction of windowless, controlled-condition plants, which have demonstrated their efficiency during the war period. Such plants, with twenty-four hour control of lighting and year-round atmospheric control, have made it possible for many industries to coordinate varied processes in straight-line operations, with improvements in quality, efficiency, and employe relations.

As electronic devices and other mechanical developments render production and control equipment more efficient, the cost of air-conditioning will be progressively reduced and the value of controlled-condition plants increased.

Post-war industrial plants will utilize many new materials, some of which were barely developed before wartime restrictions put them on the shelf. New concrete and masonry techniques developed in the effort to conserve materials have made a permanent place for themselves in the industrial building field. Many other new materials and advanced types of building equipment, already perfected, have been held up by industry's preoccupation with war activities, and will make their first appearance in these new plants.

In this connection, it is to be hoped that cities which are still hampered by outmoded building codes will revise them promptly, so that their industries and home owners may realize all the economies and benefits of modern construction. While certain more progressive cities have already overhauled their codes, a great number are still laboring under regulations that perpetuate inefficiencies for the benefit of particular groups.

Quite apart from the bearing of such codes on industrial buildings, there is no reason why the cost of homes should be increased merely because material interests or trade groups have persuaded their city councilmen and building commissioners that such things as welded or prefabricated building materials are "unsafe." The function of building codes is to protect the public through measures that insure sanitation and safe construction, and it is as much their province to recognize the safety of new and proved building materials and techniques as to prevent the construction of fire traps.

The end of the war and the lifting of wartime restrictions on construction will automatically release a substantial volume of engineering and construction for the purposes already indicated. The continuance of that business and the volume it attains will depend, however, on the speed with which industry and business are released from restrictive regulations and taxation which leave no incentive for capital investment.

Obviously all the war restrictions cannot be removed at once, but it is never too soon to plan for their removal. The Government, with the advice and counsel of industrial leaders, could well afford to start now on a survey of these regulations, with a view to modifying or removing them, one by one, as conditions permit.

If such steps are delayed until the war is over, the whole tide of post-war industrial developments, much of which starts with construction, will be held back; and if this occurs, prolonged unemployment will confront many who would otherwise find work. For countless enterprises are ready to go ahead as soon as business is confident that Government will respect and encourage the development of industry under the free enterprise system which has been the basis of America's prosperity and growth.

"Where new plants are needed, management will not be satisfied with buildings that do not offer the basic facilities for efficient production and a contented body of employes. Wartime experience has proved that man-power shortages and labor difficulties can be minimized by the right working conditions."

Non-Metallic Piping

T. F. J. MOFFETT

Wartime restrictions of metal have increased the use of non-metallic tubing and pipe. Properties of several types of pipe are summarized.

PLASTICS and other non-metallic materials for the fabrication of tubing and pipe are being used widely because of the shortage in metals. Critical needs have resulted in substitutions, many of which normally might not have been attempted or even considered. As is often the case, that which first appears in a new field as a substitute, often remains by virtue of its own inherent capabilities. Thus, many new applications for plastic, asbestos cement, and fiber pipe may well become permanent or at least as permanent as post-war competition will permit.

Plastic Piping

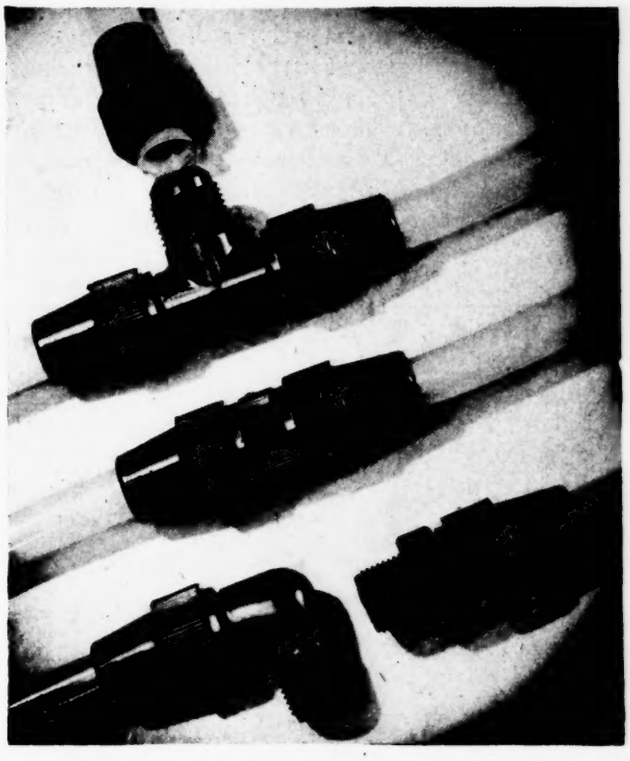
Plastics in the tubing and piping field created a mild sensation among prospective buyers. Imaginations were stimulated to visualize applications which had afforded difficulty in the past due to certain undesirable characteristics inherent in metal piping. Many of these anticipated applications have become tested realities, and plastic tubing and pipe have thereby become enhanced. Other applications are in trial and have not yet been proven.

It should be recognized that plastic tubing and pipe are made of materials essentially different from metal. Their successful application and installation require a careful consideration of certain basic factors. Thus, heat and temperature are important in the application of plastic tubing. To take a specific example, Saran, a thermoplastic developed by the Dow Chemical Company, is not resistant to continuous heat above 170F nor to intermittent heat above 212F. It is subject to distortion when its temperature reaches 150 to 180F and begins to soften in the temperature range of 240 to 280F. These critical temperatures place definite restrictions on its uses, although it should be emphasized that the length of time for which the tubing is subjected to a given temperature is also an important factor. It has been found that critical temperatures can be somewhat exceeded for short periods without deleterious results.

Plastic tubing and pipe, with changes in temperature, contracts and expands differently from metal pipe. In the case of Saran, the coefficient of thermal expansion is ten times that of steel. Thus, as a matter of practical installation, allowances should be made, according to the length, to prevent any strain developing at the connections due to cooling and contraction. Provision such as U-bends must also be made to prevent buckling with rising temperature, where considerable expansion is anticipated. For pancake shaped or helical type coils, there should be provided a liberal pipe movement with changes in temperature.

Applications at Close to Critical Temperatures

It would appear that the suitability of plastic tubing in household water systems would be questionable in view of the upper temperature limits frequently experienced in water heating. However, Saran tubing and fittings have been specified for use in 15,000 war housing units with the approval of the Federal Public Housing Administration. To keep the temperature of the hot water lines below the critical point of the plastic pipe used, thermostatic controls were specified. There appears to be no question concerning the suitability of the plastic tubing for use in cold water lines, where pressures

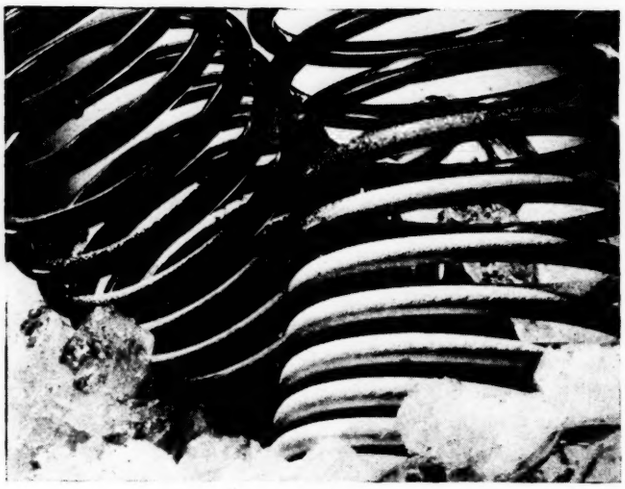


Plastic tubing and plastic fittings of a standard flare-type design.

are within allowable values. Allowable working pressures for Saran tubing are given in Table 1. As can be seen from the table, its strength varies appreciably with changes in operating temperature.

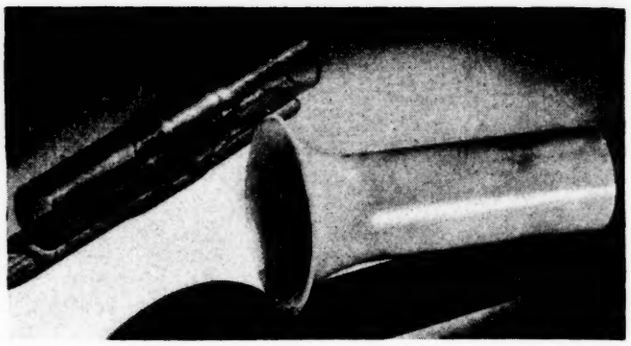
Another application in which the temperatures experienced range close to the critical limit of the plastic pipe is in the Dow Magnesium Corporation plant where the mass production of magnesium by the electrolytic method required an abundance of d-c. The large rectifying units utilized to supply this power are water cooled and nearly 4,000 feet of Saran pipe and fittings have been installed to connect these units with heat exchangers.

Circulating pumps force water through cooling



Freezing and melting of water will not injure this plastic tubing.

jackets of the rectifiers and the heat removed is taken from the water by the exchangers through which river water is circulated. The peak temperature range is said to be from 140 to 160F, with the return lines at 85F. Saran pipe is a non-conductor and so provides an effective insulation to prevent the 600 volt potential of the rectifier water jackets from being grounded through the heat exchangers to the river water piping system. Based on tests, it is claimed that the life expectancy of Saran pipe in this application far exceeds that of the rubber type formerly used.



Plastic tubing can be flared for use with standard flare-type fittings or it can be joined by telescoping and cementing the two ends.

Tenite Tubing

Another plastic tubing is Tenite, product of Tennessee Eastman Corporation. This tubing softens in a range from 140 to 250F depending upon the grade of plasticity. The softer the grade, the more it is affected by high temperatures, while on the other hand the harder the grade the more it is affected by low temperatures. The harder grade is considered most suitable for ordinary industrial requirements. Where contact with foods or drugs is involved, this pipe may be sterilized by dipping it for a few minutes in boiling water without causing any appreciable softening. Use at temperatures above 140F for any considerable period of time is not recommended.

For extremely low temperature applications, a semi-rigid tubing made of ethyl-cellulose and a highly flexible tubing made from a Vinyl base resin are available on priority order. Both types of tubing are shock resistant at sub-zero temperatures.

TABLE 1.—SIZES, WEIGHTS AND ALLOWABLE PRESSURES FOR SARAN PLASTIC TUBING

Size				Bursting Pressure	Working Pressures in Lbs. per In.² S.F. = 5:1				
O.D., In.	Wall, In.	Approx. Lbs per Ft	Approx. Ft per Lb	At Room Temp., Lb per Sq In²	0° C 32° F	25° C 77° F	50° C 122° F	80° C 176° F	100° C 212° F
1/8	.031	.0069	144	1875	515	375	245	165	130
3/16	.031	.0116	87	1200	330	240	155	105	80
3/16	.045	.0152	66	1750	480	350	230	150	120
1/4	.031	.0162	62	750	205	150	100	65	50
1/4	.045	.0218	46	1250	345	250	165	110	85
5/16	.031	.0208	48	650	180	130	85	55	45
5/16	.062	.0370	27	1500	415	300	200	130	105
3/8	.031	.0254	40	570	155	115	75	50	40
3/8	.062	.0462	22	1200	330	240	155	105	80
7/16	.031	.0300	33	460	125	90	60	40	30
7/16	.062	.0554	18	1060	290	210	140	90	75
1/2	.045	.0484	21	600	165	120	80	50	40
1/2	.062	.0646	15.4	880	245	180	115	80	60
5/8	.062	.0831	12	710	190	140	90	60	45
3/4	.062	.1001	9.9	580	155	115	75	50	40
3/4	.125	.1847	5.4	1200	330	240	155	105	80

TABLE 2.—CHEMICAL RESISTANCE OF SARAN PLASTIC TUBING

Chemical	Stability Rating	Chemical	Stability Rating
Sulphuric acid—98%	Fair	Methyl iso-butyl ketone	Fair
Sulphuric acid—60%	Excellent	Carbon tetrachloride	Good
Sulphuric acid—30%	Excellent	Ethylene dichloride	Fair
Sulphuric acid—10%	Excellent	Diethyl ether	Poor
Hydrochloric acid—35% (conc.)	Excellent	Dioxane	Not recommended
Hydrochloric acid—10%	Excellent	Benzene	Fair
Nitric acid—65% (conc.)	Good	O-Dichlor benzene	Fair
Nitric acid—10%	Excellent	Ethyl gasoline	Excellent
Glacial acetic acid	Excellent	Turpentine	Excellent
Acetic acid—10%	Excellent	Triethanolamine	Excellent
Sulphurous acid—5%	Excellent	Lubricating oil	Excellent
Concentrated oleic acid	Excellent	Linseed oil	Excellent
Sodium hydroxide—50%	Good	Bromine water	Test in service
Sodium hydroxide—10%	Good	Chlorine water	Test in service
Ammonium hydroxide—28%	Not recommended	"Chlorox" bleaching solution	Excellent
Ammonium hydroxide—10%	Not recommended	Duponol—10%	Excellent
Ammonium hydroxide—1%	Test in service	Zinc hydrosulfite—10%	Excellent
Ethyl alcohol	Excellent	Calcium chloride—15%	Excellent
Ethyl acetate	Fair	Ferrous sulphate—15%	Excellent
Acetone	Fair		

When plastic tubing is bent or coiled, it must be heated, and allowance made for spring-back. Saran tubing, for example, should be formed at room temperatures to a curvature of about seven-eighths the desired finished radius and an allowance made for 25% spring-back after it is heated. This heating should be at 212F for 15 to 20 seconds and may be conveniently done with either boiling water or atmospheric steam.

By this method, depending on size and wall thickness, it can be bent without kinking to a radius of from two to five times its diameter. For sharper bends, an internal pressure of 200 to 500 lb per sq in. is required, depending on the wall thickness. Larger tubing sizes may require a hot glycerine or oil bath for a higher forming temperature.

In some applications, the tubing may be bent cold into coils and held in place with fasteners or clamps. The Beer Utilities Company, New York City, have used over 35,000 ft of Saran tubing for beer and beverage coolers and tap lines. Tubing supplied by this distributor is rolled cold to form and clamps are furnished to hold these forms in place.

Tubing Resistant to Chemicals

An outstanding advantage offered by plastic tubing and pipe is its chemical resistance. It has a wide range of applications involving gases and liquids corrosive to metal pipe. Saran piping may carry water, air, liquid, Freon, ethyl gasoline, lubricating oil, turpentine, linseed oil, kerosene, bleaching solution, glycerine, ethyl and methyl alcohols, and most acids and alkalies. A list of chemicals for which at present it is and is not considered suitable is given in Table 2.

Tenite II withstands most acids up to 10% concentration; most alkali solutions, up to 10% concentration, show little or no effect on it. It has been used extensively in cooler lines for water, beer and carbonated water. It is, with few exceptions, however, subject to attack by organic solvents.

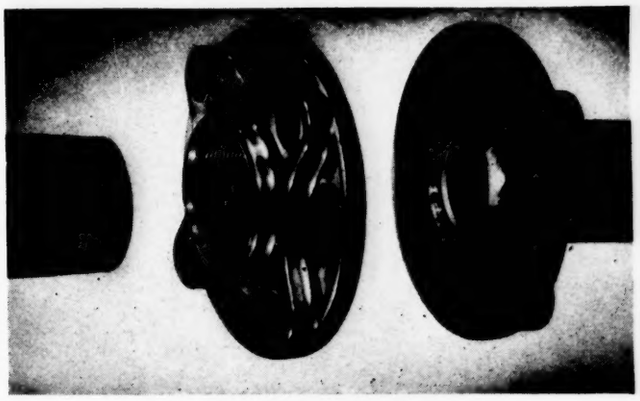
In plastic tubing manufacture the plastic is fed in granular form or as a powder into a hopper at one end of an extruding machine and is then forced by a feed screw through a heater section. Here it is melted and forced out through a die in the form of continuous tubing. This tubing may be obtained, where priorities permit, in lengths of hundreds or thousands of feet. Plastic tubing comes in diameters ranging from ⅛ to 2½ in. with several wall thicknesses for almost every size. Plastic pipes come in lengths of 10 to 20 ft and range in diameter from ½ to 4 in.

Tenite tubing comes available in a wide range of colors including black and the transparent form. The standard Saran color is a translucent yellow. Saran flare type fittings, threaded fittings and pipe are black.

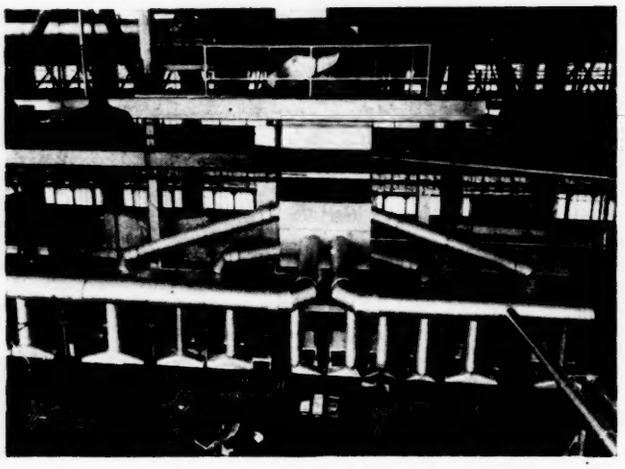
Tubing made from the same plastic are marketed under the trade names of the representative extruders.

Fittings for Plastic Tubing

Several types of fittings for plastic tubing are used including the flare type union fittings similar in design to the standard type, brass union fittings first developed by the Society for Automotive Engineers and extensively employed for coupling small copper



Plastic pipe threaded for use with plastic fittings of conventional design.



Corrosion immune asbestos cement pipe in process fume ventilation installation.

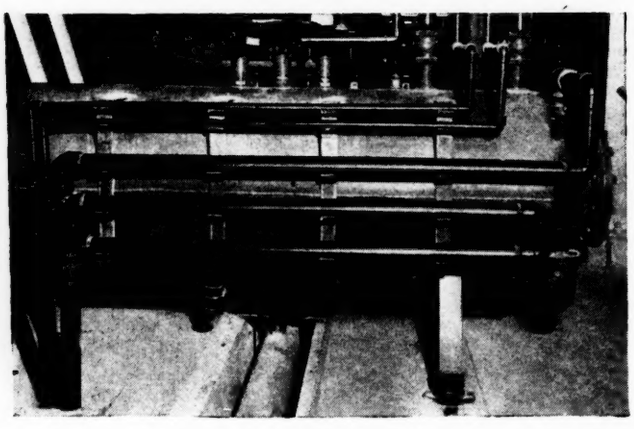
Fume ventilating stacks provide a particularly suitable application for asbestos cement pipe.

tubing. These fittings are made of the same plastic as the tubing. When used, the ends of the tubing to be coupled together may be flared at room temperature or they may be dipped into boiling water to soften them for the flaring tool. Slip-joint type fittings with compression washer rings are also available. Where special fittings are not employed, the two ends may simply be telescoped, after one end is flared by heating, and held by a suitable cement or a sleeve-like coupling, or a size larger tubing may be cemented or "welded" over the joint ends.

The "welding" or fusing of ends of plastic pipe has been found practicable in many instances and is relatively easy to accomplish. With Saran, pipe as large as 4 in. diameter can be joined in less than a minute by heating the two ends and then holding them tightly together until the softened plastic solidifies into a solid mass. Heating can be accomplished by merely holding the ends of the pipe against an ordinary electric hot plate. A good weld made in this manner, it is claimed, is actually stronger than the pipe itself.

Elbows, offsets, or tees may be fashioned by cutting the pipe ends at the proper angle and joining them by this method. Where desired, plastic pipe may be threaded with ordinary piping tools. Conventional fittings, also of plastic, may be employed.

Plastic tubing has proven itself in the chemical field. It is also particularly suitable where a pipe must be an electrical non-conductor. It is serviceable in munitions plants where sparking through accidental impact with iron piping must be avoided. Because of its high fatigue resistance, it is being utilized for connecting parts which are in relative cyclic motion, causing a constant flexing action of the tubing. Other discovered uses cannot be disclosed because of wartime restrictions.



Plastic pipe is proving satisfactory in this heat exchanger installation. Injection molded plastic elbow fittings are used.

Plastic Fittings for Metal Pipe

A few types of plastic fittings for use with metal pipe may be enumerated. The American Moulded Products Co., Chicago, Ill., supplies a liberal assortment of standard pipe size threaded plastic plugs. These are useful for the protection of threads or pipe openings, and may be employed as low pressure stoppers. Couplings and bushings in heavy standard pipe threads, made of Formica, have been on the market for many years. These are particularly useful in preventing the passage of stray electric currents which often run through illuminating gas lines. Such plastic plugs and fittings provide a substitute material and also serve in places where ferrous fittings might corrode. The plumbing industry is providing plastic flush elbows and coupling nuts for connections which ordinarily would be made with chromium plated brass. The sizes are from 1¼ to 2 in. They could be used in air washers, low pressure industrial tanks, etc.

At first the introduction of plastic products promised some real relief from the critical shortage of certain types of metal pipe and tubing. But plastics themselves have become very critical materials, reserved in first priorities for Army, Navy or Merchant Marine use. Up to mid-August, 1943, at least, manufacturers of plastic tubing and pipe reported that their salesmen were obliged to decline many orders.

Asbestos pipe with pressure type coupling in place. Note exceptionally smooth interior of pipe.

As many new applications have not been made public because of their military character, the post-war use of plastic is not clear. It is known, however, that plastic tubing is being used in aircraft because plastic tubing is less than half the weight of aluminum and only 1/7 that of brass.

Asbestos Cement Pipe

Aside from plastics, there are other very useful non-metallic pipes. Large amounts of asbestos cement pipe are being used for street water mains, sewers, drains and conduits, and also for heating and ventilating. Johns-Manville, makers of Transite, states that for several years Transite plants have been operating seven days a week and 24 hours a day.

Transite pipe is made up from asbestos fibers and cement, combined under heavy pressure over polished steel mandrels into a homogeneous structure. The pipe is light in weight, is resistant to corrosion, electrolysis and fire. In the heating and ventilation line it is known best for uses as industrial ducts, vents and stacks. In air conditioning, the pipes have been used underground, in basements as supply or return air mains. For water lines and for pressures of from 50 to 200 lb per sq in. it comes in sizes from 3-inch to 36-inch diameter. It is widely employed as a chimney or vent flue for gas burning boilers or heating equipment. It is practically a standard specification for the exhaust systems at many chemical plants, and it is used for removing dangerous fumes and dust. Since early in the war emergency, Transite pipe of various weights and classifications has been employed extensively in Army and Navy bases and structures, in housing, munition plants, and mines, and in industries producing oil products and high octane gasoline, synthetic rubber, plastics, airplanes and tanks.

Asbestos cement piping developed by the Philip Carey Manufacturing Company is composed of an intimate mixture of asbestos fiber, portland cement, and graded silica. In the wet state, it is "extruded on and over a smooth cylindrical mandrel under continuous pressure" until a dense, uniform tube has been formed. The product seems to have been designed particularly for underground electric conduits. It comes in 5 ft lengths in inside diameters of 2, 2½, 3, 3½, 4, 4½ and 5 in. There are two wall thicknesses, ⅞ in. and ⅝ in. The material appears to be immune to acids, alkalies, salts and such chemicals as are normally present in the ground. It is capable of withstanding continual exposure to heat, moisture, frost, steam and sewer gas.

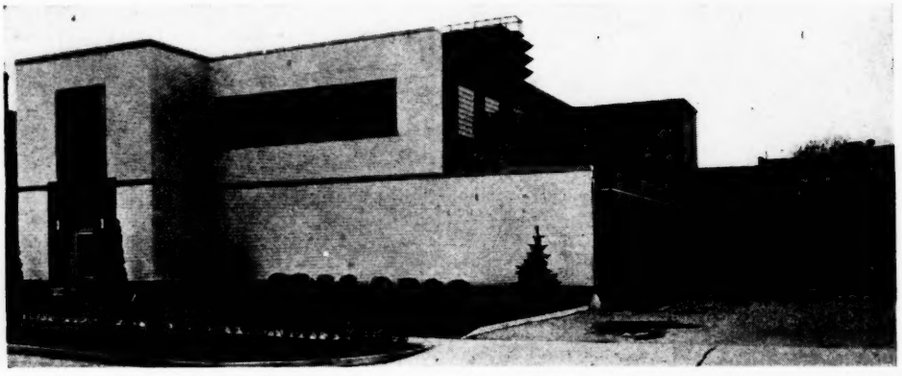
It comes in straight lengths with a loose coupling for connections at each end; a special asbestos fiber reinforced asphalt mastic is used as a joint sealing compound. A length of 4-inch conduit with ⅞-inch walls, sealed at both ends and placed under hydrostatic test, has a bursting pressure, it is claimed, of 365 lb per sq in. The material stands up well under flexure, crushing and impact tests. Available fittings include Y-branches (called laterals), short and long sweep elbows, adapter couplings for accommodating metallic line junctures, reducers, plugs, etc.

Another type of asbestos-cement pipe, Eternit, manufactured by The Ruberoid Co., is made by a patented extrusion process. The product is a dense, strong pipe with an exceptionally smooth inner surface. This pipe is readily cut with a hacksaw and can be coupled at any point without the aid of a machine. Either Flexlock or Dresser pressure couplings may be used for joining this pipe.

The heating and air conditioning engineer will recall that his designs sometimes require the handling of considerable waste water. Ordinary connections from buildings to street sewers or other outlets are made of cast iron bell and spigot pipe, or similar vitrified tile or concrete pipe. In the past few years, there has been a greatly increased use of asbestos cement pipe. For instance, Transite waste pipe comes in 2, 2½, 3, 3½, 4, 4½, 5, and 6 inch sizes in standard 10 ft lengths, and an 8-in. size in 13 ft lengths. House connections to sewers or disposal fields ordinarily are 4, 5, or 6 in. Sleeve-like couplings fit over the pipe ends and permit a slight deflection away from strictly straight runs where desired.

Fiber Pipe

Exceptional demands for piping have also brought about an increased use of fiber pipe for drains, sewer connections, septic tank disposal fields, inside roof downspouts, and greenhouse irrigation systems. The materials used are well impregnated with hard pitch. The pipe is light in weight and in short lengths, easy to handle or ship. It may be cut with an ordinary saw. The Fiber Conduit Company, Orangeburg, New York, are specialists in this line. Crane Co. are national distributors. The product has been used particularly for the protection of underground cables for 50 years.



New plant of General Ice Cream Corp., Rochester, N. Y.

Dual automatic boiler installation supplies hot water for processing and domestic requirements, and for heating the building.

KENNETH SPRAGUE
Syracuse Office
Bell & Gossett

Forced Hot Water Heating for Ice Cream Plant

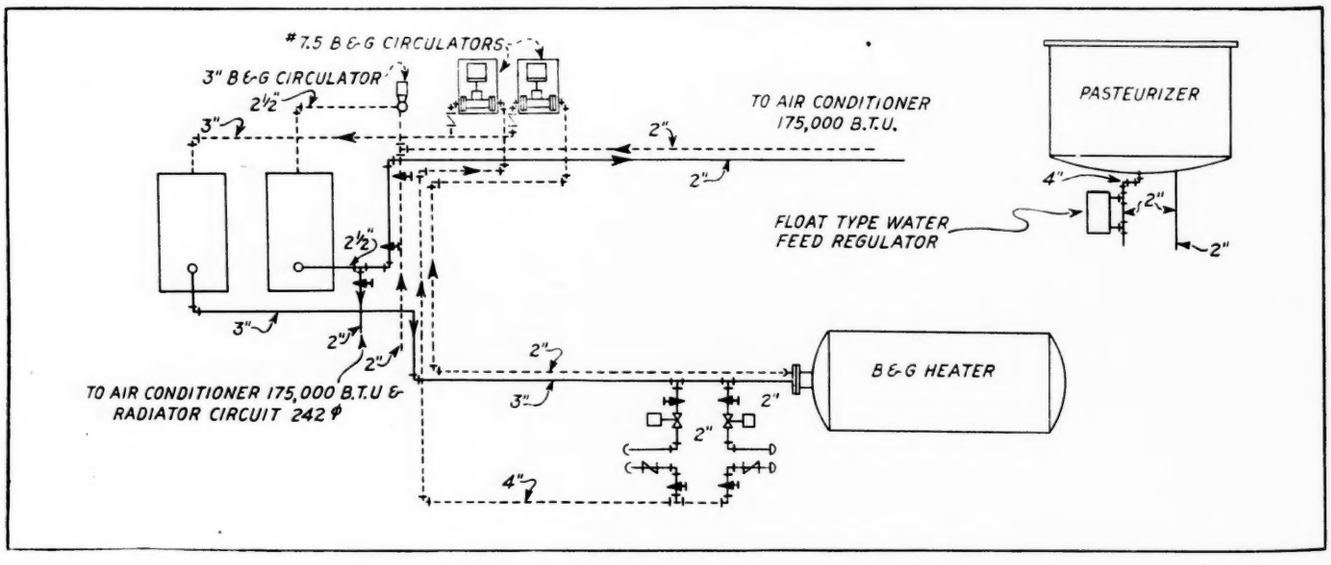
ANOTHER example of the expanding use of forced hot water as a means of heating a building and its adaptability to the industrial or processing field, is The General Ice Cream Corporation plant in Rochester, N. Y. This plant has been in operation for about four years, so that there has been ample time to observe its operation as far as each unit or phase of work is concerned.

In planning for the heating equipment installation, the consensus of opinion was that forced hot water would make for a better operating plant and would solve many of the difficulties customarily experienced in a dairy plant when the usual method of utilizing steam for heating is employed. One advantage of using forced hot water in a dairy plant is the reduction of excess vapors released into the atmosphere during sterilization.

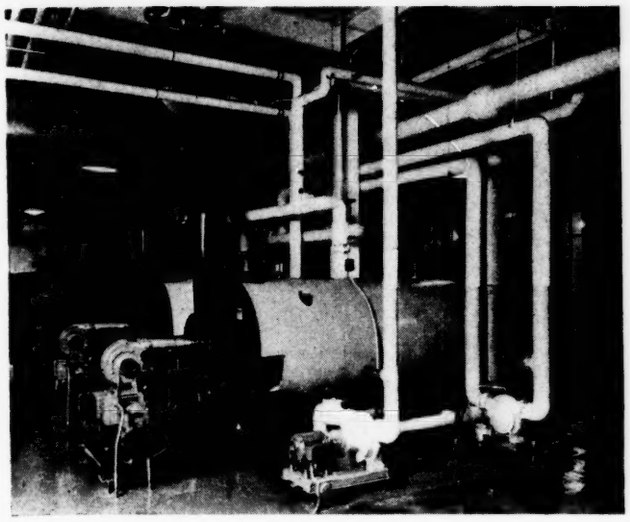
The building is of two-story brick construction. On the first floor is a large ice cream storage and hardening room, which is kept at a temperature of — 10F or lower. Ice cream manufacturing and pasteurizing equipment is located on the first floor, while boiler room and refrigerating equipment are installed in the basement below. Directly above the sub-zero room are the main office, locker rooms, and showers, for the employes.

Both the heating of the building and the processing load are handled by a dual automatic hot-water boiler installation. The boilers are cross-connected so that either one can be used for any of the plant work. For normal operation, however, one boiler is used to take care of the heating and the other, the processing.

The heating plant has three distinct duties to perform: (1) to heat the building; (2) to pasteurize the milk and cream; and (3) to take care of the



Arrangement of the hot water system which takes care of both processing requirements and domestic load.



Dual automatic hot water boiler installation. The two boilers are cross connected so that either may be used for any of the heating needs of the plant.

domestic hot water load. The last item is very large and includes the hot water supplied for general sterilization as well as that which is circulated through kettles for melting chocolate.

The heating system is of special design and provides heat to the main office, located directly above the sub-zero hardening room, without requiring the installation of any pipes in the ceiling of the hardening room. A forced air fin coil conditioning unit is located on the building roof and the heat for the main office is furnished by warm air circulation. Hot water is pumped through the fin coil of the air conditioning unit by a centrifugal pump at the boiler. A more even temperature is maintained than would be possible with steam.

The locker rooms, loading dock office and other working areas are heated by radiation from a modern down-feed Monoflo system. Piping is laid out on the one-pipe plan with special Monoflo tees in the main at the supply and return to each radiator. The circulation pump in the heating part of the system operates continually during the heating season.

The different parts of the building are zoned and the equipment is adjusted so that each zone is heated to the exact temperature required.

Method of Pasteurization

The processing and pasteurization end of this installation presents a new and interesting phase in the use of forced hot water. Pasteurizing is taken care of by two stainless steel vats with a capacity of about 500 gallons each. These are filled with milk and cream which is usually at a temperature of 40 to 45F, then sugar flavoring and other ingredients are added. The entire contents of each vat must then be brought up from 45F to 165F in a period of not more than thirty minutes. Vat temperature is maintained at 165F for about thirty minutes and is then pumped through a cooler and on through the actual ice cream processing equipment.

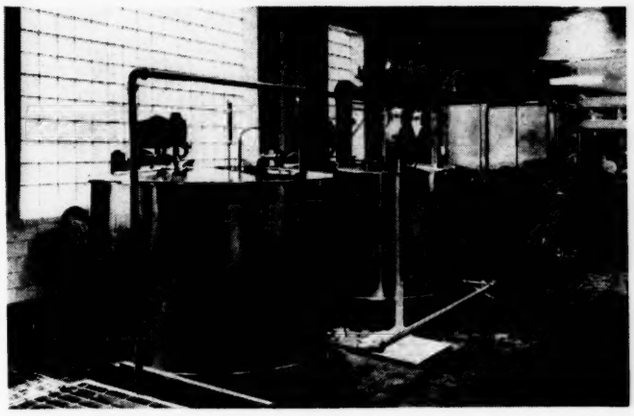
Hot water for heating these large pasteurizing vats is pumped directly from the boiler through the exterior compartment of the vats and is returned to the boiler by gravity. This eliminates the need for any intermediate transfer apparatus and makes for maximum economy in the operation. This pump must deliver not less than 125 gpm of water from the boiler at 200F.

Another large pump handles the water circulation for the domestic water load which is not less than 1,000 gph of water at a temperature of 180F. This is taken care of by utilizing the hot water storage tank originally installed in the old plant. The steam coil was replaced with a water coil of sufficient size to handle the load. This new hot water coil is functioning equally as well as the high pressure steam coil previously used.

The centrifugal pump furnishing water through this water coil in the tank must deliver not less than 80 gpm of water at 200F directly from the boilers. The boiler water is pumped direct from the boiler through the heating coil and return. A small pump at the storage tank is used to circulate the water at 180F from the storage tank through kettles for melting chocolate when necessary.

At the present time this plant is the only one belonging to the General Ice Cream Corporation which is operating entirely on forced hot water. Steam is not generated in this plant. Results obtained have been so satisfactory that after the present emergency, forced hot water will undoubtedly be a definite "must" in the corporation's post-war planning.

The design of this plant was handled by Melvin L. King and Harry A. King, architects, and the engineering through the office of Robson and Woese, Inc., consulting engineers. Both firms are located in Syracuse, N. Y. James T. Garvin, of the General Ice Cream Corporation, who has had a wide experience in the dairy industry, worked very closely with them.



These two 500-gal pasteurizing tanks are supplied with hot water at 200F which raises temperature of the controls from 40F to 165F in 30 minutes.

Germicidal Aerosols For Post War Air Conditioning?

F. W. HUTCHINSON.

Assistant Professor of Mechanical Engineering,
University of California, Berkeley, California.

During late 1941 and early 1942 HEATING AND VENTILATING published a series of six articles on Health Factors in Air Conditioning by Professor F. W. Hutchinson, covering health vs. comfort vs. efficiency; temperature; acclimation; humidity; refrigerants as a health hazard; and atmospheric sabotage. These most interesting reviews of the literature on the various subjects covered are now followed by a series on Secondary Health Factors in Air Conditioning, of which the accompanying article is the first.

DISCLOSURE that the present shortage of "Freon 12" is in part due to use of this refrigerant in a "mosquito bomb" has served to focus the attention of air conditioning engineers on a relatively new method of air quality control which may find wide application in post war design. The Army's mosquito bomb is of unusual interest, not because it represents a new type of insecticide—it doesn't—but because it does represent a unique contribution of engineering to the problem of placing an existing insecticide in such proximity to the insect that effective killing can take place. Freon 12, as used in the bomb, provides the high pressure charge which, on release, disperses the insect-killing constituents (sesame oil and extract of pyrethrum flowers) and causes rapid spreading of these constituents to all parts of the enclosure; the odorless, practically nontoxic characteristics of this refrigerant make it particularly useful for the purpose.

Behind the drama of this "bomb", its war time application and its unique use of a common refrigerant, lies the less sensational, but possibly more significant, fact that the killing power of the basic insecticide has been enormously increased by dispersing it, as an aerosol, in the same form which has been studied as a means of sterilizing air. Similarly, aerosols have been found effective as a method of destroying objectionable odor, increasing the intangible quality of "freshness" in an enclosed space, or reducing the minimum fresh air intake for odor dilution. In recent years an immense amount of basic research has been carried on to determine methods of effectively creating aerosols (an engineering problem) and to investigate the effectiveness of the active materials as deodorants, insecticides, or germicides (a medical problem). The interest in this subject of the practical air conditioning contractor and engineer arises from the ever increasing possibility that war time acceleration of such research may hasten the day when aerosols can be effectively used in comfort air conditioning installations to purify and freshen the air while simultaneously reducing winter operating costs by decreasing ventilation requirements. Such possibilities are, as yet, only hopes for the future but hopes which seem to warrant present interest.

Establishing an Aerosol System

The effectiveness of an aerosol suspension of germicide, deodorant, or insecticide depends on the extent and distribution of the active liquid surface and the time interval during which this surface is maintained. Fundamentally, therefore, a material to be used as an aerosol first must be very finely atomized and spread, as a mist, throughout the enclosure; secondly, the properties of the active ingredient, or of other materials with which it is associated, must be such that rapid vaporization will not occur. From the air conditioning engineer's point of view the problem of dispersing material as an aerosol is therefore similar to the first half of the problem of humidification. The humidifying problem is to rapidly create a large surface (as by atomization) and *rapidly* achieve evaporation from it; the aerosol problem is to rapidly create a large surface, but *delay* evaporation from it.

For the above reasons a satisfactory fluid for use as an aerosol must have a low vapor pressure. Many otherwise effective antiseptic solutions cannot be successfully used as aerosols because of their high vapor pressures. Solution of the active antiseptic in water or in some other innocuous solvent is usually desirable and the addition of some hygroscopic material —as glycerine—is helpful in delaying evaporation of water from the droplets. In the same way maintenance of a high vapor pressure in the space to be sterilized would—by reducing the evaporation rate —be expected to prolong the active life of the aerosol. In this connection most investigators have found that greatest effectiveness is realized in the relative humidity range from 60% to 90%. Twort and Baker (1942) have found that the activity of germicidal aerosols declines when the relative humidity is lowered to 50% and drops off almost to worthlessness in air at 30%. However, this characteristic cannot

be entirely attributed to increased rate of evaporation as other factors, such as greater resistance of the bacteria, may be, at least in part, responsible.

Germicidal Aerosols

The possibility of improving health through use of bacteria-free air rests largely on the assumption that known disease is air borne. This belief was established by the work of Pasteur and is today widely accepted by laymen. Science, however, has consistently found other explanations for the transmission of disease and at present the accepted view voiced by Chope and Smillie, is that, ". . . epidemiological evidence has been accumulated which shows that most of the infections that were once considered as air borne are undoubtedly transmitted through other vehicles. But it would be a great mistake to conclude without further evidence that air plays no part as a vehicle in the transmission of communicable diseases." Most of the work which is being done with germicidal aerosols is directed against bacteria or known types of virus suspensions which have been conclusively shown to be responsible for illness and disease. In this respect it is noteworthy that the effectiveness of such antiseptics depends on the specific type of virus which is to be inactivated; thus the kind of active material to be used as an aerosol depends on the particular purpose.

Pulvertaft and Walker experimented with sodium hypochlorite solution and report that it is highly effective as an aerosol though requiring concentrations which are high as compared with other materials. Decided advantages of this material are low cost, effective deodorizing and the imparting of a pleasant odor to rooms in which it is used. Masterman rejects the aerosol theory as applied to hypochlorite spraying and asserts that the active germicide resulting from use of this material is hypochlorous gas. He states that approximate sterility can be realized by using HOCl gas in air with a volumetric concentration less than 1 part in 3½ billion.

Challinor (January, 1943) reports on the use of atomized hypochlorite in a room having a density of occupation of 100 cubic feet per person. The solution was atomized by means of a hand spray type of Flit gun using .38 of a volume of solution for each million volumes of air. A 33% reduction in bacteria count was observed immediately after spraying, but the count increased again within 15 to 20 minutes. The presence of tobacco smoke reduced the effectiveness of the mist. An odor was noted in the room for a few minutes after spraying but few irritant or corrosive effects were observed and the occupants thought the odor pleasant and the air "freshened."

British investigators report the effective use against influenza virus of a supersaturated aqueous solution of resorcinal with glycerin. Where the presence of a visible and odorous mist would be objectionable they recommend intermittent sterilization of the air by means of the aerosol with removal of the mist after approximately one hour by means of ventilation. This method could be used to advantage in such intermittently used spaces as school rooms, theatres, and churches. In fancy at least, the air conditioning engineer can visualize mist sterilization as an "attachment" to a residential air conditioning mechanical ventilating system which would permit daily use by the housewife as part of the routine of house-cleaning.

Recently (May, 1942) Twort and Baker reported that hexylresorcinal and resorcinal are the most effective germicidal aerosols of the phenol group which have so far been investigated. Hexylresorcinal is less rapid in its action, but is effective in weaker concentrations and retains its bactericidal power for a longer time. In conditioned spaces having a high density of occupation and a rapid ventilation rate resorcinal would therefore be preferred, while for low density enclosures with few air changes (as residences) hexyl resorcinal would be the better. Atomization of either of these germicides can be accomplished either mechanically or by use of a hot plate. These investigators did not find appreciable loss of germicidal effect due to the presence of secondary mists or smoke in the space treated with the aerosol.

Tests of triethylene glycol as an aerosol are being conducted by Robertson and associates. In a February, 1943, paper they report that 1 gram of this glycol per 100 to 200 million cc of air showed pronounced bactericidal action.

Bactericidal Effects of Present Air Conditioning Methods

Closely related to any discussion of aerosols or any other means of sterilizing the air of an occupied space is the question of effectiveness of present air conditioning methods and processes in reducing the bacteria count. Contamination of air occurs, of course, from causes among which are discharges from the body during the respiratory process, or in a sneeze or cough. The dispersion of particles by such means is in part dependent on air motion within the occupied space and in part on the direction in which occupants are facing and the initial velocity of the material leaving the body. During a sneeze, for example, particles may be discharged at velocities in excess of 100 miles per hour. At such speeds the kinetic energy of the larger particles (1 mm or over) will easily carry them across a living room of average size; smaller particles leave with equal velocity, but have a surface volume ratio so great (for .1 mm or less) that their kinetic energy is dissipated before they have traveled any appreciable distance from the source. Particles of the latter type are dispersed largely by random air currents.

Dispersion of micro-organisms already within an occupied space is increased if drafts occur across the floor or if a high floor air velocity (50 fpm or greater, according to Yaglou) is caused by improper distri-

bution. Downward supply systems are said to be least desirable in this respect.

The effect of humidity on bacteria is not yet established. Wells has found that dehumidification will kill Beta Streptococci (group C) to a degree comparable with results from use of propylene glycol (as a fumigant) with or without hexylresorcinal. Edward and associates, on the contrary, found that infective nuclei carrying influenza virus persist much longer in dry, rather than humid, atmospheres. Noteworthy is the fact that these two opposite findings are not contradictory; they indicate merely that the procedure for inactivation of a particular type of virus may be determined by the type and may vary widely among types.

The effectiveness of such air conditioning equipments as blowers, filters, or air washers as agents for removing bacteria is hardly encouraging. Yaglou reports that commercial filters remove from 40% to 60% of normal room organisms from recirculated air, but such organisms may actually be recovered from dry or viscous filters after a brief period of continuous operation. Similarly, commercial air washers are capable of removing 40% to 80% of bacteria from recirculated air providing they are supplied with sterile water; if recirculated water is used without addition of a disinfectant, such washers may *add* organisms to the leaving air stream.

Summary

Present air conditioning processes are not noteworthy for their effectiveness in establishing pure and "fresh" indoor atmospheres. One proposed method of improving this condition is through use of finely atomized mists of solutions having pleasant odors and bactericidal power. Development work on such germicidal aerosol has been accelerated as a consequence of the war and there is now a distinct possibility that such aerosols may become a standard part of post war air conditioning installations.

Metallic Dusts Tested by Bureau of Mines

To safeguard the lives of hundreds of thousands of industrial workers and minimize the dangers of fires and explosions in war plants, the Bureau of Mines has ascertained the inflammable characteristics of many of the powdered metals used or produced in factories turning out weapons and other equipment for the Nation's fighting forces.

Founded upon many years' experience in the testing of the inflammable characteristics of coal-mine dust, the Bureau's work in the powdered metals field is being conducted at its laboratories at Bruceton, Pa., where some of the equipment used for the mine-dust work has been modified to handle metallic dusts and powdered material submitted by industries.

Among the metallic dusts tested were aluminum, antimony, cadmium, chromium, copper, iron, lead, magnesium, tin, zinc, and zirconium.

Zirconium, a costly metal which is used in ammunition primers, has been described as "particularly dangerous" by the Bureau's research workers, said Dr. R. R. Sayers, Bureau Director. In the tests at Bruceton, a cloud of zirconium powder ignited spontaneously at room temperature and exploded, whereas other metallic dusts in the "highest explosibility" class required temperatures hundreds of degrees higher before they ignited. As a result of the tests, the Bureau recommends that powdered zirconium be handled only as a sludge or in special containers. Zirconium has a wide range of industrial uses and is employed, in various forms, in welding rod flux, in radio tubes, in the production of armor plate, and in furnace refractories.

Fuel Interests Plan $2,500,000 Research Program

Increased and better utilization of bituminous coal by fully-automatic home heating and summer cooling apparatus, smokeless stoves, and other developments are expected to result from a 5-year $2,500,000 research program announced by Bituminous Coal Research, Inc. The directors of the bituminous industry's research agency followed recommendations of its technical advisory board in reaching its decision in a meeting at Battelle Memorial Institute, where an extensive program is already in progress.

Twelve major research investigations involving over ninety specific topics and affecting the consumption of virtually the total annual bituminous coal production, which is scheduled to reach 600 million tons this year, are contemplated.

Cooling of residences in the summer by the same coal-fired plant that heats it in the winter, conversion of coal into gas without by-products, and household stokers that automatically take coal from the bin and put the ashes into containers are among the leading subjects scheduled for investigation. Coal-burning heaters and ranges that heat steadily all day and night without smoke and with only infrequent attention and one rekindling a season are to be developed. To insure that stoves, stokers, and furnaces will meet with public satisfaction, high standards of performance are to be sought through the adoption of rating codes and tests of these manufactured products. Chimney construction will be given attention to assist architects and builders eliminate faulty designs. Further testing of pulverized coal is necessary.

How to Design Exhaust Hoods

By J. M. DALLA VALLE

Engineer,
American Air Filter Co.,
Louisville, Ky.

Part 11—Hood Entrance Losses

Local exhaust system design requires some knowledge of the losses incurred at the various openings. Such losses are as important as the proper estimate of duct resistances.

Opening losses can be shown to be proportional to the corresponding velocity heads. Hence, entrance losses may be expressed as percentages of the velocity head. The air velocity in the duct connecting a hood is given by the equation:

$$V = 4000\, f \sqrt{h_s} \quad \ldots\ldots (33)$$

where V = the air velocity in the duct in feet per minute when h_s is measured,
f = a factor called "coefficient of restriction," and
h_s = the static suction in the duct in inches of water.

The same velocity is also given by the equation:

$$V = 4000 \sqrt{h_v} \quad \ldots\ldots (34)$$

where h_v is the velocity pressure as measured by a pitot tube.

Hence,

$$h_v{}^{1/2} = f(h_s)^{1/2}$$

Moreover, since $h_s = h_e + h_v$ where h_e = entrance loss, we obtain

$$f = \sqrt{\frac{h_v}{h_e + h_v}} \quad \ldots\ldots (35)$$

Various types of hoods for which entrance loss factors are known, are shown in Fig. 84. With the exception of Type 4 hoods, data are available on entrance losses sustained when the hoods are flanged. Hood dimensions and corresponding entrance losses and restriction coefficients are shown in Table 19. It is seen from this that the entrance losses for a plain duct are nearly equal to the velocity head. The losses in the square and rectangular openings appear to be lower, but it must be remembered that these losses are expressed in percent of the velocity head in the exhaust duct. If we compare the effect of hood shape on the entrance losses of corresponding duct ends themselves, we find that flaring actually results in a decrease from 50 to 70% of the velocity head. However, if a comparison is drawn between two types of openings of equivalent areas, the losses are not necessarily decreased by flaring. Table 20 illustrates a comparison between an 8 in. diameter duct end and a 5 x 10 inch flared opening connected to a 5 in. diameter duct, both areas at the opening being approximately the same. Thus, although the entrance loss in the 5 x 10 in. hood is about one-half that of the 8 in. diameter duct end in percent of the air velocity in the exhaust duct, the actual entrance loss in inches of water gauge is three times as great.

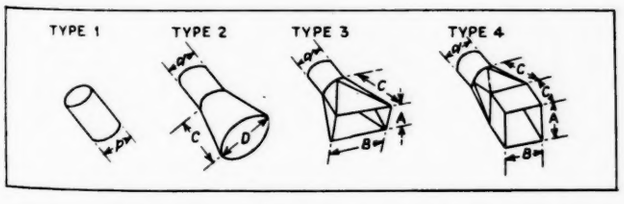


Fig. 84. Dimensions of hoods referred to in Table 19.

TABLE 19.—ENTRANCE LOSSES FOR HOOD TYPES ILLUSTRATED IN FIG. 84.

Type of Opening	Dimensions (Inches)				Entrance Loss Factors			
					Plain Opening		Flanged Opening	
					% h_v	f	% h_v	f
	d							
Circular (Type 1)	4				97	0.712	42	0.839
	6				107	0.695	46	0.838
	8				115	0.682	50	0.816
	D	d	C					
Type 2	8	4	6		25	0.895		
	A	B	C	d				
Rectangular (Type 3)								
Side ratio 3:4	4.1	5.5	5	4	39	0.849	29	0.890
	6	8	6	6	49	0.820	39	0.849
	7.5	10	7	6	46	0.838	33	0.865
Side ratio 2:3	4	6	6	4	29	0.890	20	0.912
	5	7.5	7.5	5	51	0.814	46	0.838
	6	9	9	5	46	0.838	39	0.849
Side ratio 1:2	4	8	7.5	4	29	0.890	20	0.912
	5	10	10	5	55	0.804	49	0.820
	6	12	12	6	44	0.834	36	0.858
	8	16	12	8	40	0.851	27	0.888
Side ratio 1:3	3	9	6	3	53	0.809	39	0.849
	4	12	8	4	37	0.854	33	0.865
	5	15	10	5	51	0.814	51	0.814
	8	24	12	8	62	0.785	56	0.800
	A	B	C′	C	d			
Square (Type 4)	4	4	10	4	4	77	0.752	49	0.820
	6	6	10	5	4	—	—	50	0.816
	8	8	10	5	8	79	0.748	53	0.809

(Concluded on page 100)

Collection and Disposal of Magnesium Dust

JOHN M. KANE
American Air Filter Co., Inc., Louisville, Ky.

THE greatly increased use of magnesium in the manufacture of parts for aircraft and other war products has brought attendant hazards of fire and explosion due to the extreme inflammability of the fine magnesium particles produced. Thus, a great deal of attention has been given to finding the best means of collecting and disposing of magnesium dust and chips to avoid the danger of their ignition.

A small burning particle of magnesium when carried through an exhaust system can quickly ignite the collected material in a dry dust collector or accumulations at various points in a poorly designed exhaust system. The burning of these accumulations ordinarily proceeds so rapidly that flarebacks and pressures of explosive proportions can easily occur. Because of this ease of ignition, the accepted methods of handling other materials equally as explosive are ineffective and unsafe practice for magnesium.

So much magnesium was being used in the manufacture of wartime products that some safe and economical plan was needed for handling the incidental dust. Dry magnesium dust is a serious fire hazard. This article suggests how magnesium dust can be collected and disposed.

When water is used as a collecting medium and the magnesium particles are stored in a flooded state, they cannot be ignited. Stored magnesium in a flooded state should not be confused with damp material which does ignite readily. The small amount of hydrogen generated by the reaction of magnesium and water is readily vented to the surrounding air in a very dilute, safe concentration.

Oil vs. Water as a Collection Medium

While water has been found very suitable for the collection and storage of fine magnesium dust, the use of a high flash point oil has also been suggested as a collection medium. A comparison of the characteristics of oil and water in dust collecting service will indicate the respective advantages of each.

There is no reaction between oil and magnesium to liberate hydrogen. Any damp accumulations on collector surfaces stay oily and do not dry out. There is no critical mixture of oil and magnesium where the burning of magnesium is accelerated. Oil may provide better quenching to any burning particles carried to the dust collector. Collected particles removed from the collector are coated with oil and can be more safely stored and disposed.

On the other hand, considerable oil will be lost by entrainment and adherence to collected material representing added operating expense. Oil vapors in the exhaust air will probably prevent recirculation of the cleaned air. Supply of makeup oil and the use of satisfactory oil relies on the human element. Dust collectors cannot be easily drained to facilitate removal of collected material.

Excellent experience over an extended interval on a large number of unit type dust collectors employing water indicate that many of the advantages of oil are more theoretical than actual. The amount of hydrogen generated is diluted well below any hazardous concentration and is much lower than concentrations from pickling and anodizing tanks. Water is inexpensive, of consistent quality and provides an unlimited source for makeup. Dangers of oil fires are eliminated. Most collectors using water can recirculate the cleaned air to the workroom providing flexibility in equipment re-location.

On the basis of the above comparison, it is apparent that oil is a safe collecting medium, but with the limited experience in the field and with the extensive satisfactory experience where water has been used, it is premature to recommend it as superior to water for safe operation of dust collectors.

In the following discussion water has been assumed the collecting medium, but the comments and recommendations apply also for systems using oil.

Stand Grinding, Polishing and Buffing Operations

Large quantities of fine magnesium dust are produced during grinding, polishing and buffing operations. This dust affords the greatest possibility for serious fires. A dust collector of the unit type employing water as a collecting material should be used. Air moving equipment should be on the clean air side and the collected dust should be stored under not less than six inches of water.

Exhaust volumes and velocities recommended for ferrous grindings by the American Foundry Association and State Codes should be used. Where large castings are ground, hoods that are larger than usual may require an increased volume through larger branches to compensate for the larger hood openings.

Castings with recesses or pockets often accumulate considerable dust on their inner surfaces during grinding, polishing or buffing. The air exhausted

Unit type dust collector located directly behind the magnesium grinding stand precipitates the dust and stores it safely under a head of water. Interlocks prevent operation of the collector without safe volume of water and prevent operation of the grinder unless collector is in service.

from the wheel hood oftentimes will not pick up these accumulations. Consequently, it may be necessary to provide an auxiliary down draft grille on which castings can be tapped to remove such accumulations.

The use of unit collectors minimizes possible injury to personnel and equipment by confining any fire that should develop to a restricted area. Long duct runs are eliminated with the attendant possibility of accumulations due to poor design or unbalanced air distribution.

The collector should be located directly behind each grinding stand or polishing jack, thus making connections from hood to collector as short as possible. Recesses where dust could accumulate such as traps in the hood or duct, blast gates and dead-end caps must be avoided. Cleanouts are normally not required in such short duct connections, but if installed should be on the top side of the duct and should conform closely to the duct contour. Such cleanouts serve as excellent inspection doors if the interior of the ducts is not accessible at any point.

The motor on the grinding stand or polishing jack should be interlocked with the exhauster motor so that the machine cannot be operated unless air is exhausted from the wheel hood.

Water from nozzles in hood or duct is not required with the unit collector system. Nozzles in the hood may cause damp spots where deposits will adhere. Such deposits would present an additional hazard by partly drying out during the shut down period. Water in ducts complicates the dust collection equipment and requires considerable auxiliary equipment.

Installations for Flexible Shaft Grinding, Polishing and Buffing Equipment

The fine dust produced by flexible shaft grinding, polishing and buffing operations creates a potential hazard almost as great as that of the grinding stand or polishing jack. The collection and disposal of this dust can be handled by using a ventilated bench with a grilled top that provides air intake of not less than 200 cfm per square foot of gross working area. The bench design should be such that dry particles cannot accumulate in the opening beneath the grill or on any ledges or hopper walls. Not more than four operators should be employed on one ventilated bench and side shields should be provided to protect each operator.

The water reservoir may be incorporated directly beneath the bench and a wet type dust collector used, making possible the elimination of all duct connections and the storage of collected material under a safe head of water.

Where this water reservoir is located directly under the work grille, an interlock between exhauster motor and the flexible shaft motor is not essential but is recommended. Its use prevents the dispersion of fine dust over the workroom by assuring exhaust ventilation at all times when the grinders are in operation.

Exhaust Ventilation for Filing Equipment

In many plants no exhaust ventilation is provided for flexible shaft filing where only coarse magnesium particles are removed, as particles in this range do not present the potential hazard of fine dust. Like chips from machining operations, the coarse particles do not burn at the violent rate of fine magnesium dust, and fires can be controlled by conventional magnesium fire extinguishers.

Such operations can be exhausted, using the same arrangement discussed for flexible shaft grinding, polishing and buffing. The use of a ventilated work bench greatly improves housekeeping and undoubtedly increases production due to the improved working conditions, the elimination of time for frequent cleaning up of accumulated chips and the distraction

Intricate aviation engine castings of magnesium are finished with flexible shaft files, burrs and grinders. Fine dust is immediately removed by a downdraft stream of air through the grille top of a special work bench which incorporates a safe magnesium dust collector.

caused by occasional fires in such areas. These factors can easily offset the loss in salvage value due to wet collection, as the quality and quantity of particles from flexible shaft filing do not approach the salvage possibilities of chips from machining.

Band sawing can be placed in the category with flexible shaft filing. The particles are relatively coarse and the operation has been safely handled without exhaust in a number of plants. Exhaust ventilation, however, has distinct advantages. With the high cutting speeds used, magnesium particles are scattered over a wide area. Here again, time lost in housekeeping and in putting out the not infrequent fires can quickly justify exhaust ventilation.

The same recommendations given for stand grinding, polishing, buffing apply. In addition to the conventional exhaust connection beneath the table, an auxiliary connection will be required to collect the flying particles that are not carried downward by the saw blade, where risers are cut at appreciable heights above the table.

The exhaust requirements for abrasive cleaning should follow the A.F.A. Code. Where the abrasive is sand, the bulk of the dust is sand fines and the magnesium content is too small to require special consideration. Where metallic abrasive is used, the proportion of magnesium in the exhausted dust is appreciably higher.

In such cases the dust collector should be of the wet type, storing the collected dust under water. Ducts should be free of dead-end caps or recesses where quantities of dry dust could accumulate. Cleanout doors should be on the top of the ducts to eliminate accumulations. They can be spaced every 20 feet or less and be provided with chained or hinged covers to serve as pressure reliefs in case of fire. This area should be not less than the cross-sectional area of duct.

On all dust collectors handling magnesium, the following precautions are recommended:

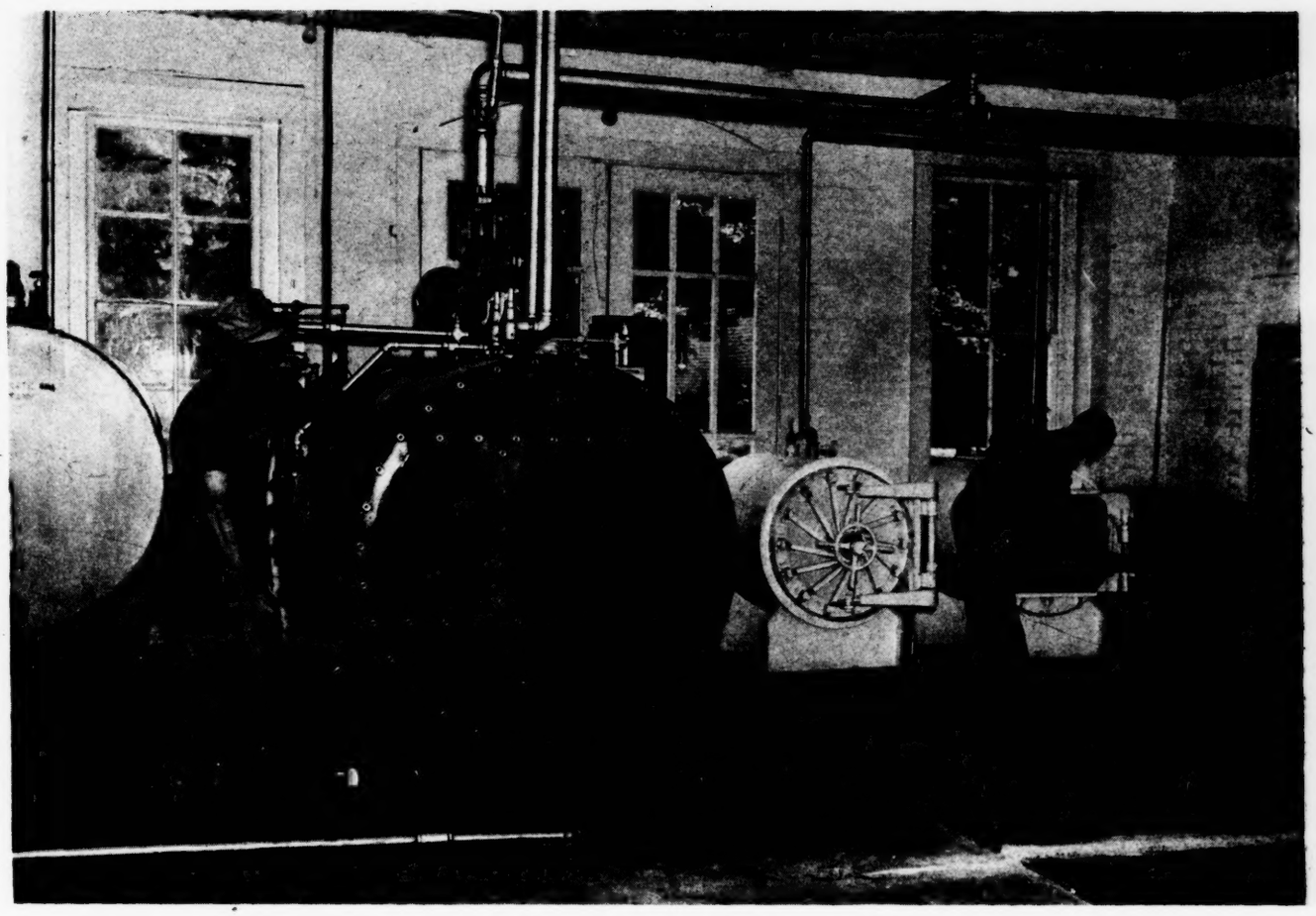
1. Totally enclosed motors should be used to prevent settlement of fine floating particles in motor windings.
2. All equipment should be grounded.
3. A protective device should be provided with the dust collector to prevent operation unless correct liquid flow and proper liquid volume is maintained to assure safe operation.
4. Equipment used for working magnesium must not be used for ferrous metals unless thoroughly cleaned beforehand.
5. Extreme care should be exercised in the use of cutting torches or welding for repairs. All collector parts should be cleaned thoroughly and access doors left open before such repairs are started.

Disposal of Collected Dust

To date, the hazard involved in attempting the salvage of fine dust from collectors has made its reclamation infeasible. Safe disposal will vary with the quantity collected and plant conditions.

Early recommendations suggested mixing the collected dust with five parts of sand and burying it in a dumping area. Shortcomings of this method became apparent in plants where large quantities of dust required disposal or where combustible material was dumped in the same area.

In most plants magnesium dust is now burned in an open outdoor area on a layer of fire brick sloped to allow drainage. Wet dust from collectors contains approximately 50% water and consequently is difficult to ignite. A layer of dry refuse placed over the dust provides a safe means of ignition. In burning, it supplies the necessary heat to dry the magnesium sufficiently and at the same time acts as a blanket absorbing much of the heat and light from the burning metal.



Gas-fired steam boiler and water tank (left) and blanchers (right) for processing sweet potatoes.

Sweet Potatoes Processed for Army

King Pharr Co., Cullman, Ala., uses dry-steam dehydration equipment for other vegetables. Equipment and food handling procedure described

GEORGE H. WATSON

EQUIPMENT for dehydrating 10 to 12 tons processed sweet potatoes per day was recently put into operation by the King Pharr Company, at Cullman, Ala. The entire output of the plant is now going to the U. S. armed forces.

Equipment for the plant was designed and installed by Cleaver-Brooks Co., of Milwaukee, and includes a 30 hp oil-fired steam generating plant, a 43x10x7-foot dry-steam dehydrator, and necessary machines to prepare potatoes for dehydration.

Potatoes on being brought to the plant from nearby farms, are put through the following units before they are ready for the dehydrator: A washer; automatic steam-operated caustic peeler; steam pressure washer; inspection table where imperfects are thrown out; final washer; slicer (which will also dice or strip); another bath; to trays where the potatoes drain, and then to the blancher.

From the blancher trays of sliced potatoes are wheeled into the dehydrator or tunnel, constructed of several thicknesses of asbestos board with cork insulation. There are two operations in the tunnel. First the product is subjected to a temperature of 212 to 220F with 110F wet bulb temperature. Potatoes are then shifted to the other end where the temperature is lowered to 140-160F to prevent carbonization of the potatoes while most of the moisture is removed. Potatoes remain in the tunnel from 7½ to 8 hours and during this time about 93% of the moisture is removed.

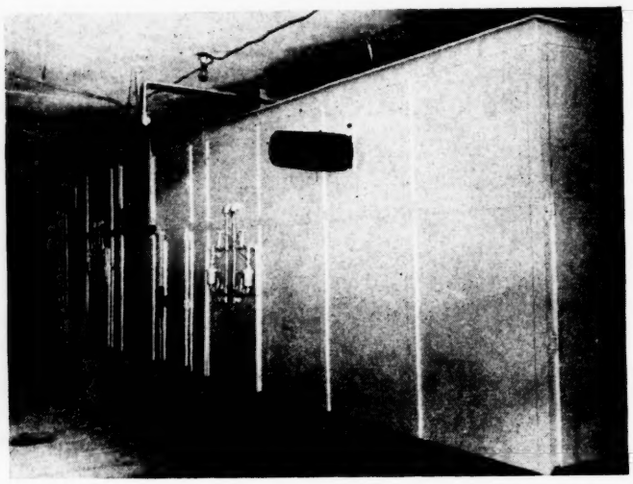
Heat for the dehydrator is provided by steam coils. Air is circulated over the coils by means of a 7½ hp fan on the high temperature end, and a 5 hp fan on the low temperature end. Johnson controls automatically regulate both heat and humidity. The blancher in the preparation line is also equipped with Johnson controls.

Trays of potatoes as they leave the dehydrator are rolled into the packing room and packaged in lead foil lined pasteboard containers, measuring 12x12x6 in. The package even if thrown in the water is waterproof for several hours. Packages are agitated as filled to shake down the light weight filling and then are machine sealed.

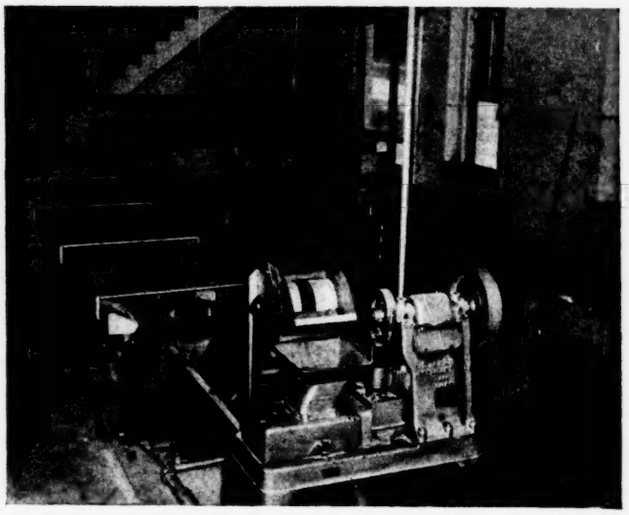
King Pharr, operator of the plant, said he expects to handle 5,000,000 pounds of raw sweet potatoes within a year. Dehydration reduces this amount to about 900,000 pounds and the product looks like a new breakfast food. With water added, it tastes like sweet potatoes in the original state.

Dehydrated potatoes will keep indefinitely; without dehydration and under favorable temperature and moisture conditions but a few months.

While sweet potatoes only are being packed, the company expects it will later also pack Irish potatoes and other vegetables. The equipment can be adjusted for the vegetable being dehydrated.



Dehydrator is 43 feet long, 10 feet high and 7 feet wide.



Potatoes travel from washer up an elevator to the caustic peeler, to the pressure washer, to the inspection belt, to the washer, and up an elevator to the cutter in the foreground.

Dimensional Coordination Proposed by A.S.A.

With the hope that much of the present need for cutting and fitting materials at a building site may be drastically reduced through standardization of dimensions of building material and equipment, Project A62 was started by the American Standards Association early in 1939. Joint sponsors of the move are the American Institute of Architects and the Producers' Council, Inc.

It is not the aim of the sponsoring groups to standardize building design. However, the aim is to make available stock sizes to meet existing building conditions and needs. Use of stock sizes will be encouraged so that the need for custom manufacturing will be reduced and cuts made in the number of slow-moving parts and equipment that suppliers must carry.

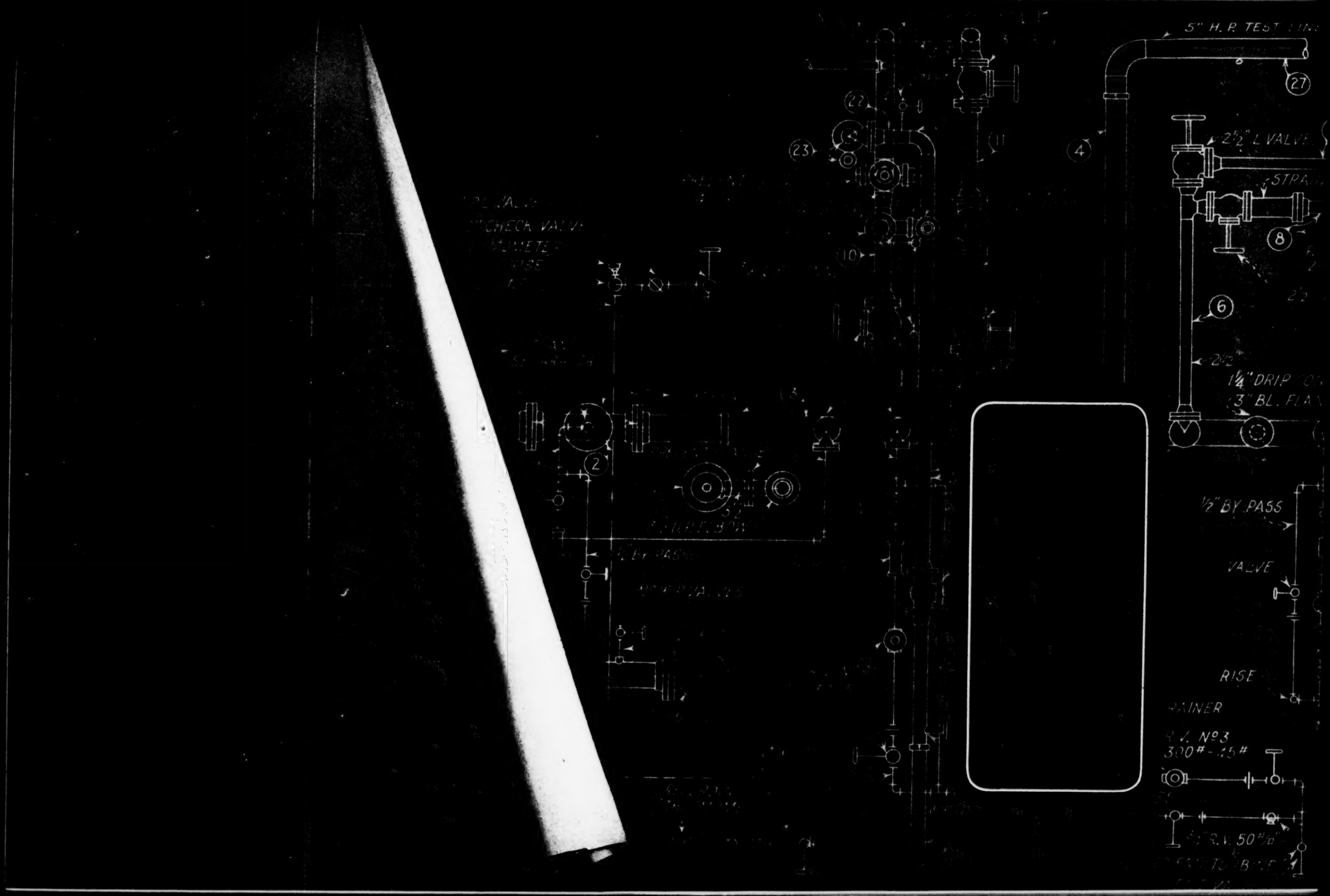
The Association points out that application of dimensional coordination to materials such as preformed clay and concrete products, and doors and windows, will avoid the cutting and fitting usually required in wall construction where these materials are used.

It will be obvious that the more completely the principles of dimensional coordination are applied, the greater will be the advantages resulting from the simplification in detailing and manufacture, speed in erection, and reduction in the cost of construction.

Since the project was started, sectional committees were formed for specialized study, and progress has been made. There are nine sub-committees as follows: Masonry Made of Structural Clay Products; Wood Doors and Windows; Masonry Made of Concrete and Cast Stone; Metal Windows; Natural Stones, including Granite, Limestone and Marble; Structural Wood; Building Layout; Structural Steel; and Miscellaneous Metal Products.

While some material and equipment does not fit in with dimensional coordination, the Executive Committee of Project A62 is satisfied that the principles are generally applicable.

Questions and comments regarding this Project should be addressed to M. W. Adams, Secretary, ASA Committee A62, c/o Modular Service Association, 110 Arlington St., Boston 16, Mass.


5" H. P. TEST LINE
27
2½" L VALVE
STRAIN
8
6
2½"
1¼" DRIP
3" BL. FLA
½" BY PASS
VALVE
RISE
RAINER
R. V. Nº3
300# - 15#
R. V. 50#
CAST TO B

THE HEAT PUMP

An All-Electric Year-Round Air-Conditioning System

By PHILIP SPORN
Vice-President and Chief Engineer,
and
E. R. AMBROSE
Air Conditioning Engineer,
American Gas and Electric Service Corporation, New York.

SINCE one method of approach to a consideration of the heat pump is through its thermodynamic cycle, much of the literature on this subject appears highly technical and involved. Actually the heat pump is a compression type refrigeration system, consisting of an evaporator, condenser, compressor and expansion valve. When operated as a refrigerating system in the conventional way it pumps heat from an enclosed space and rejects it at a higher temperature level. Since the refrigerating cycle is reversible, the system can be used to pump low temperature heat to a higher level so that it can be used for heating. To use the system for heating, the air to be heated can be blown over the condenser, while the evaporator absorbs heat from the "cold" outside air. This is one method of using the heat pump.

The heat pump and its future possibilities can perhaps be best envisioned by reviewing some installations made during the past few years in office buildings of electric utility companies with which the authors are associated, together with a study of the various factors influencing the design and performance.

Perhaps the simplest way to illustrate the action of the heat pump is by showing what happens in the refrigerant cycle. Refer to Fig. 2. The heat content of one pound of refrigerant is used as the unit. The refrigerating effect, when used for cooling, is equal to 45.6 Btu per lb of refrigerant. The condenser must reject this quantity of heat plus the heat put into the system by the compressor.

Now suppose that the system in Fig. 2 were so arranged that the evaporator were outside the building on a day when the temperature is approximately 10F and that the heating air ducts are arranged to absorb the heat given off by the condenser. This air could be heated to a point approaching the 108F refrigerant temperature leaving the condenser and thus the building could be heated. Heat absorbed by the air would be 58.3 Btu per lb of refrigerant circulated. Of this amount electric energy totaling 12.7 Btu is put into the system. The remaining 45.6 Btu is pumped from the outside air and costs nothing. The heat absorbed at the "cold" level outside is pumped to the high or 108F level.

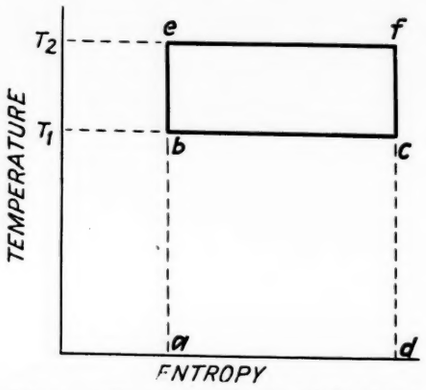


Fig. 1. Theoretical cycle of the heat pump on temperature-entropy coordinates.

The theoretical cycle of the heat pump, sometimes called the "reverse refrigeration cycle," can also be represented by the temperature-entropy diagram, Fig. 1 of the conventional refrigeration cycle.

In Fig. 1, the theoretical refrigerating cycle is made up of *cf*, the compression of the refrigerant; *fe*, a constant temperature rejection of heat in the condenser; *eb*, the drop in temperature in the expansion valve; and *bc*, the increase in entropy in the evaporator or cooling coil. The area Q_1 *(abcd)* represents the refrigerating effect and the area Q_2 *(bcfe)* the energy added (by the compressor) to accomplish this effect. The sum of Q_1 and Q_2 (area *aefd*) represents the energy rejected. When operating as a heating cycle, the energy "rejected" is used as heat, so that with an energy input of Q_2, the heating effect totals $Q_1 + Q_2$. Therefore heat obtained from the air at the low temperature level T_1 represented by Q_1 is made usable at level T_2.

Since the change in entropy is the same for the three areas, the energy quantities represented by them are proportional to the absolute temperatures. By definition, the coefficient of performance for a heat pump is the total heat output divided by the

HEATING and VENTILATING here presents the first of a series of articles to appear regularly under the title Blueprint of Post War Realities. These Blueprints are down-to-earth discussions of developments with favorable possibilities for peace-time application.

The Heat Pump, with which this first Blueprint is concerned, is not a new idea. It has received considerable attention in the way of thought, but not so much in actual installations. On the other hand, the possibility of more extensive applications was never so great as now. One reason for this is the increased capacity for manufacturing power equipment of all sorts installed during the war and which will be available for other uses when peace comes.

Another is the expansion of the electrical utility facilities which occurred during the war, although it has received surprisingly little publicity: the public so far is hardly conscious of the magnitude of the job quietly done by electric utilities during this war. With this capacity it will be natural for the utilities to seek expansion of their domestic market. In this task such ideas as the heat pump can play a more important and perhaps decisive role.

Mr. Sporn and Mr. Ambrose have had a most extensive experience in the application and operation of the heat pump and present here a picture of post-war realities that is thought interesting and exciting.—Editor

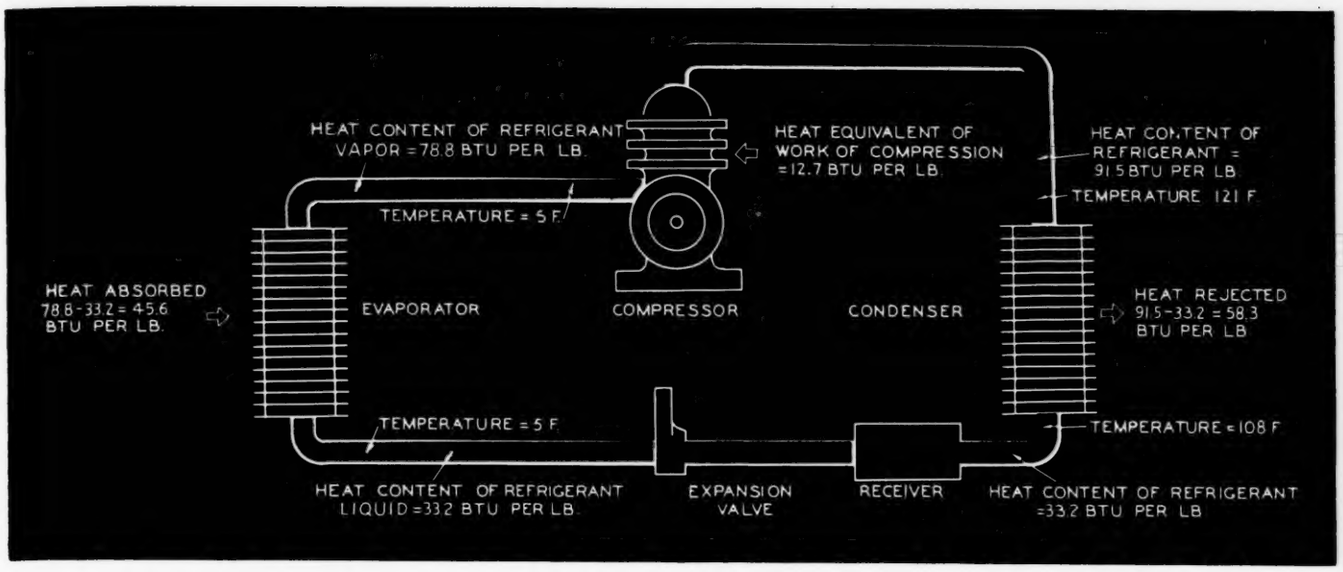

HEAT CONTENT OF REFRIGERANT VAPOR = 78.8 BTU PER LB.
HEAT EQUIVALENT OF WORK OF COMPRESSION = 12.7 BTU PER LB.
HEAT CONTENT OF REFRIGERANT = 91.5 BTU PER LB.
TEMPERATURE = 5 F.
TEMPERATURE 121 F.
HEAT ABSORBED 78.8 - 33.2 = 45.6 BTU PER LB.
EVAPORATOR
COMPRESSOR
CONDENSER
HEAT REJECTED 91.5 - 33.2 = 58.3 BTU PER LB.
TEMPERATURE = 5 F.
TEMPERATURE = 108 F.
HEAT CONTENT OF REFRIGERANT LIQUID = 33.2 BTU PER LB.
EXPANSION VALVE
RECEIVER
HEAT CONTENT OF REFRIGERANT = 33.2 BTU PER LB.

Fig. 2. Schematic diagram to show how a refrigerating machine can absorb heat from cold outside air and use it in heating a building. The enthalpies, in Btu per pound, are from Freon (F-12) tables.

heat equivalent of the work done in producing the effect so that the theoretical coefficient of performance can be represented by the equation:

$$\text{C.O.P.} = \frac{T_2}{T_2 - T_1} \quad \ldots\ldots\ldots (1)$$

Equation (1) represents the highest performance coefficient between two limiting temperatures. It will be noticed that the coefficient of performance will be improved by lowering temperature T_2 and/or by raising temperature T_1.

The coefficient of performance of an actual installation is lower than shown by equation (1) because the cycle is polytropic and not adiabatic, a temperature gradient is necessary for heat transfer, and because compressors are not 100% efficient. Actu-

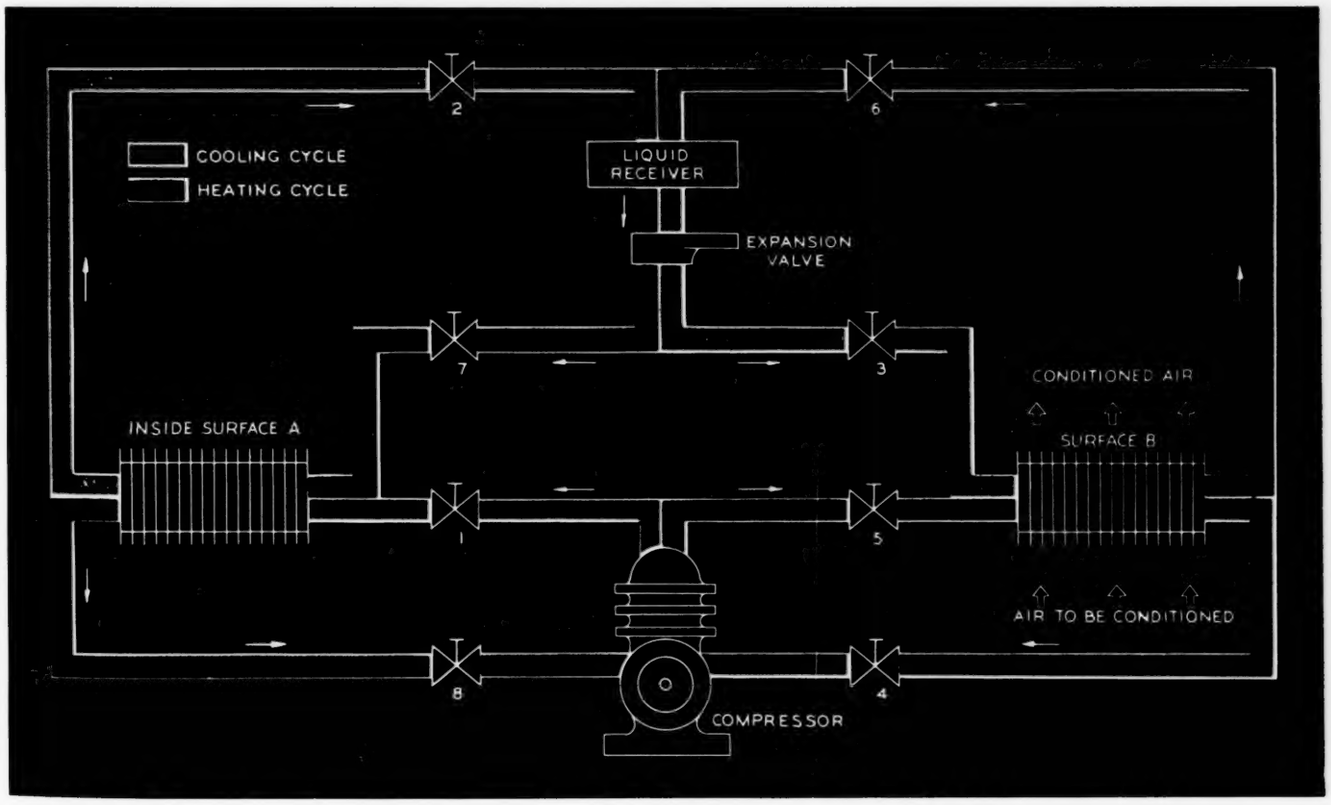


Fig. 3. Air-to-air design of heat pump using air as source of heat and as a medium to remove heat from condenser. Refrigerant path is reversed by eight two-way valves.

POSITION OF VALVES.—Cooling Cycle: Valves Open 1, 2, 3, 4; Valves Closed 5, 6, 7, 8; Heating Cycle: Valves Open 5, 6, 7, 8; Valves Closed 1, 2, 3, 4.

ally the coefficient of performance ranges from 3.0 to 5.5.

[redacted]

There are four basic types of heat pump systems. Fig. 3 shows schematically an air to air design. Air is used as a source of heat, and air is used to remove heat from the condenser. The path of the refrigerant is reversed by means of eight 2-way valves as shown.

During the cooling cycle, the gas refrigerant goes from the refrigerating compressor through valve 1 to surface *A* where it is liquefied, giving up heat to air outside the conditioned space. From surface *A*, the liquid refrigerant goes through valve 2 to the liquid receiver, through the expansion valve and valve 3 to surface *B* where it is gasified, absorbing heat from the air being delivered to the conditioned space. From surface *B* the gas returns to the compressor through valve 4.

During the heating cycle, the gas refrigerant goes from the compressor through valve 5 to surface *B* where it is liquefied, giving up heat to the air being delivered to the conditioned space. From surface *B* the liquid refrigerant goes through valve 6 to the liquid receiver, through the expansion valve and valve 7 to surface *A* where it is gasified, absorbing heat from the air outside of the conditioned space. From surface *A* the gas returns to the compressor through valve 8.

Instead of reversing the direction of the refrigerant as shown in Fig. 3, an alternate design, Fig. 4, maintains a fixed refrigerant circuit and reverses air flow. During the cooling cycle, air from the conditioned space passes through damper *A* over the cooling coil, through damper *B* back to the conditioned space. Outside air passes through damper *C* over the condenser through damper *D* to the outside.

During the heating cycle, air from the conditioned space passes through damper *G*, over the condenser, through damper *H* and back to the conditioned space. Outside air passes through damper *E* over the cooling coil through damper *F*, back to the outside air.

Fig. 5 shows an air to liquid design. Air is used as a source of heat; liquid is used to transfer the heat from condenser and chiller. In this design, the refrigerant circuit is fixed, going from compressor to condenser, through the expansion valve and chiller, back to the compressor.

During the cooling cycle, pump *A* circulates the colder liquid through the chiller, valve 4, the inside surface *C* then through valve 3 back to the pump. The circulating liquid in passing through the inside surface *C* absorbs heat from the air being delivered to the conditioned space and in turn gives up this heat to the refrigerant in the chiller; pump *B* circulates the warmer liquid through the condenser, valve 1, the outside surface *D*, then through valve 2 back to the pump. The liquid in passing through the condenser absorbs heat from the refrigerant and gives it up to the outside air when passing through outside surface *D*.

During the heating cycle, pump *A* circulates the colder liquid through the chiller, valve 8, outside surface *D*, then through valve 7 back to pump *A*. The liquid in passing through the outside surface *D* absorbs heat from the outside air which is transferred to the refrigerant in the chiller. Pump *B* circulates the warmer liquid through the condenser, valve 5, inside surface *C*, then through valve 6 back to pump *B*. In passing through the condenser, the liquid absorbs heat from the refrigerant which is transferred to the conditioned air passing over the inside surface *C*.

Fig. 8 shows a water to water design. Water is used as a source of heat, and water is used to transfer heat from the condenser and chiller. In this design, the refrigerant circuit is the same as in Fig. 5, going from the compressor to the condenser, through the expansion valve and chiller, back to the compressor.

During the cooling cycle the deepwell pump *A* circulates water from the well through valve 3, the condenser, then through valve 4 to the drain. The well water absorbs heat from the refrigerant when passing through the condenser. Pump *B* circulates water through valve 1, the chiller, valve 2 then through the inside surface *C* back to pump *B*. The water in passing through the inside surface *C* absorbs heat from the air being delivered to the conditioned space and in turn gives up this heat to the refrigerant in the chiller.

During the heating cycle, the deepwell pump *A* circulates water from the well through valve 7, the chiller, then through valve 8 to the drain. The refrigerant absorbs heat from the water as it passes through the chiller. Pump *B* circulates the water through valve 5, the condenser, valve 6, then through the inside surface *C* back to pump *B*. The water absorbs heat in passing through the condenser which, on passing through the inside surface *C*, is transferred to the air going to the conditioned space.

Fig. 9 shows a water to air design. Water is used as a heat source, and air is used to transfer the heat from the inside surface *D*. In this design the water circuit is fixed, going from the well through the deepwell pump to outside surface *D*, then to the drain.

During the cooling cycle, the gas refrigerant goes from the compressor through valve 1 to surface *D*, where it is liquefied, giving up its heat to the well water. From surface *D* the liquid refrigerant goes through valve 2 to the liquid receiver, through the expansion valve and valve 3 to the inside surface *C* where it is gasified, absorbing heat from the air being delivered to the conditioned space. From surface *C*, the gas returns to the compressor through valve 4.

During the heating cycle, the gas refrigerant goes from the compressor through valve 5 to the inside surface *C* where it is liquefied, surrendering its heat to air being delivered to the conditioned space. From surface *C* the liquid refrigerant goes through valve 6 to the liquid receiver, through the expansion valve and valve 7 to the surface *D* where it is gasified, absorbing heat from the well water. From surface *D*, the gas returns to the compressor through valve 8.

[redacted]

There are quite a few possible variations to the four basic designs; pre-cooling coils, pre-heating coils, or humidifying may be incorporated in the design. Two condensers or two evaporators may be used in the first two designs, to prevent reversing the fluid flow, or to heat one section of the space and cool another section simultaneously. It is possible that the use of four 3-way valves instead of the eight 2-way valves shown in the diagrams would result in a saving in equipment and installation cost but, on the other hand, may not always be the most satisfactory. Since cold fluid is on one side of the valve and hot on the other, the two-way valves seem to offer less chance of leakage across the valve seat and also usually offer less resistance to fluid flow.

The usual precautions of a conventional refrigeration system must be followed in a heat pump design. It is advisable to use oil traps ahead of the compressor, and to size the refrigerant piping to prevent trapping oil in the system.

In the first two designs the surfaces have a dual role of acting as an evaporator and a condenser, so that special care must be exercised that they are self-draining to prevent trapping of refrigerant and oil. In these two designs the expansion valve is exposed to high temperature-high pressure refrigerant which requires special consideration.

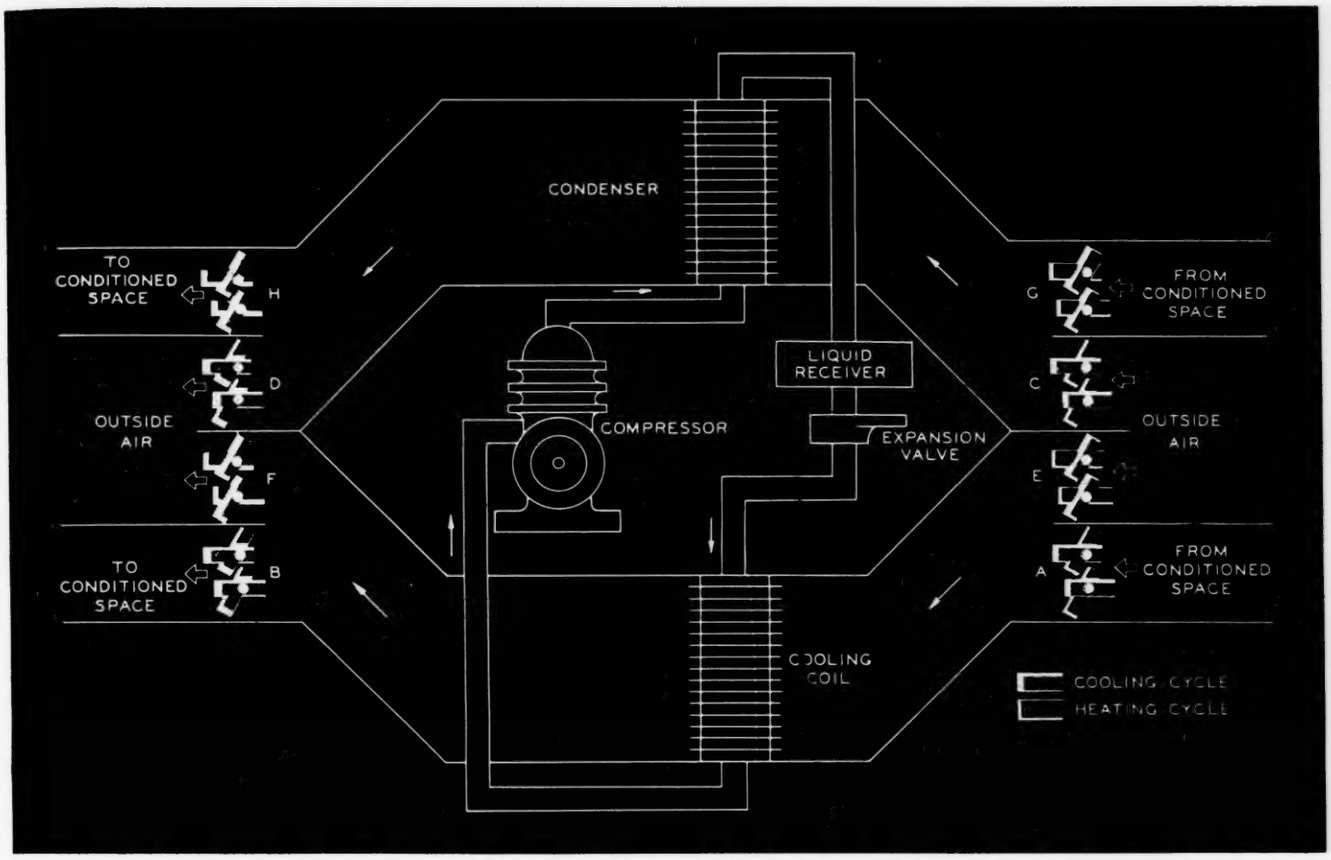


Fig. 4. An alternate (to Fig. 3) air-to-air heat pump with fixed refrigerant circuit but with air flow reversed.
POSITION OF DAMPERS.—Cooling Cycle: Dampers Open A, B, C, D; Dampers Closed E, F, G, H;
Heating Cycle: Dampers Open E, F, G, H; Dampers Closed A, B, C, D.

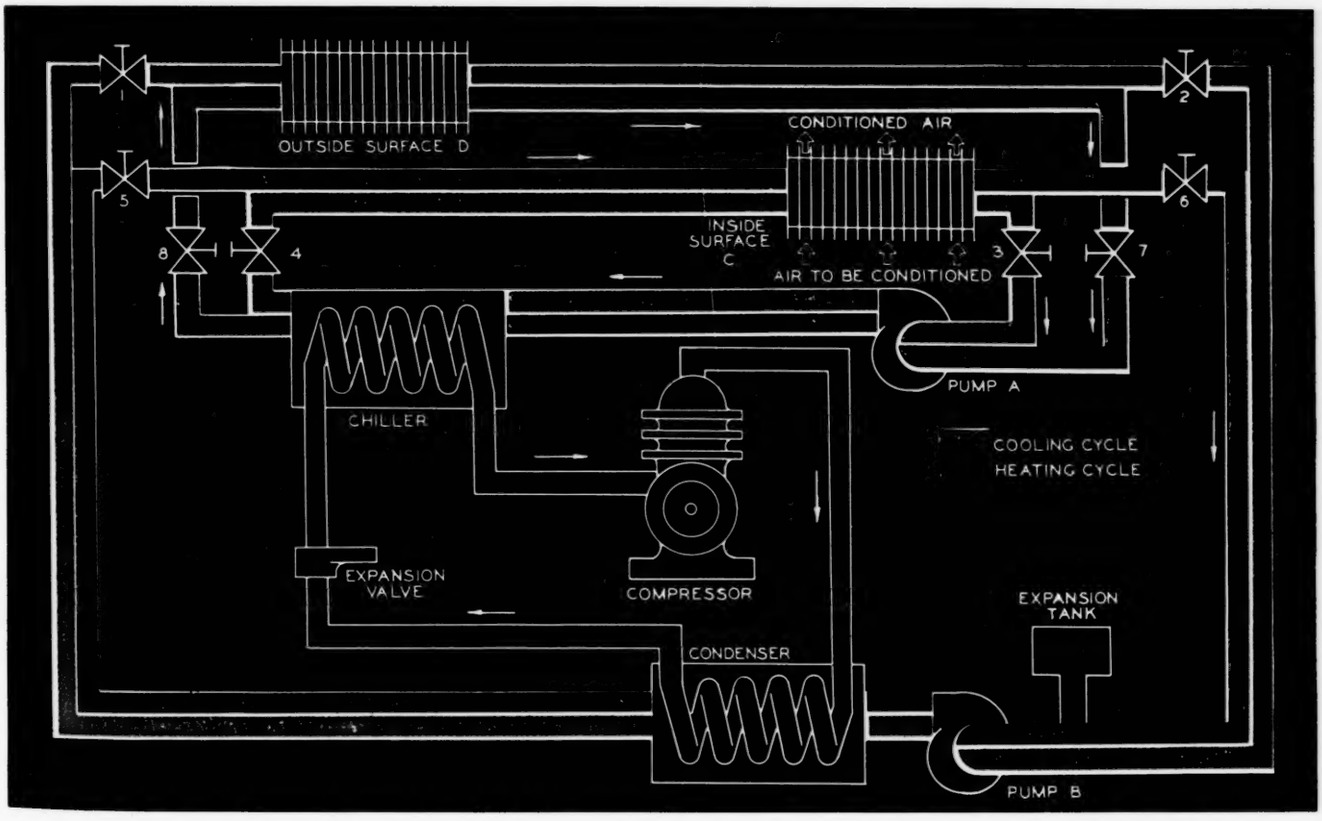


Fig. 5. Air-to-liquid heat pump with air as source of heat and liquid to transfer heat from condenser and chiller.
POSITION OF VALVES.—Cooling Cycle: Valves Open 1, 2, 3, 4; Valves Closed 5, 6, 7, 8;
Heating Cycle: Valves Open 5, 6, 7, 8; Valves Closed 1, 2, 3, 4.

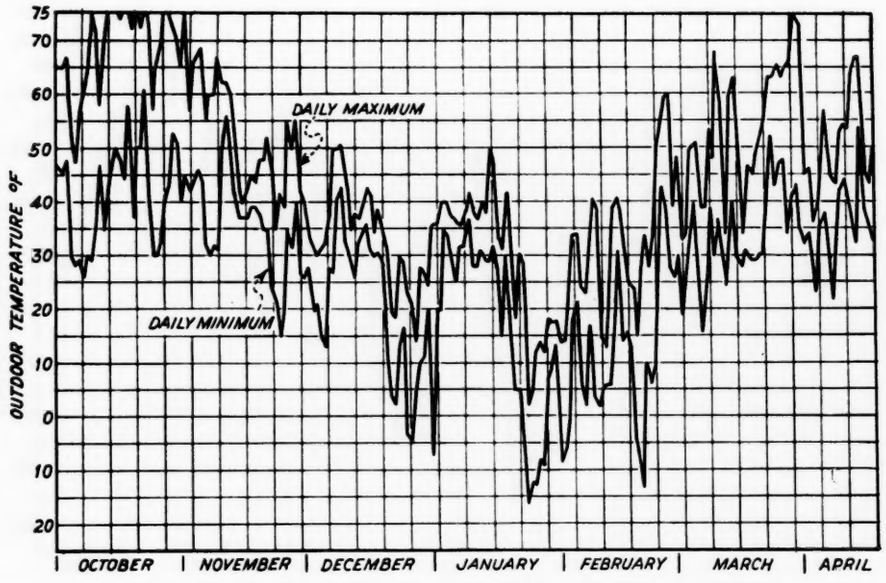


Fig. 6. Typical curves plotted from climatic data and used for determination of design temperature.

In all the designs, it is quite important to have the compressor equipped with capacity modulation features to obtain as wide an operating range as possible.

Refrigerant and water piping should be so designed that seasonable changeover is easily accomplished. This changeover can be automatic or manual, but usually automatic is preferred.

The heat pump is applicable to most any type of distribution system from the unit to the conditioned space. An air system circulating warm or cold air by means of ducts, or a water system circulating warm or cold water by means of pipes to one or more units located in the conditioned space, have been successfully applied.

The advantage of one design over another depends to a large extent on the type of building and location of the proposed system. A constant and reliable source of heat must be available; either well water or air is generally used. Well water temperature is fairly constant year round and when available, the source is usually most convenient and the least costly. However, consideration must be given to the chemical composition of the water and disposal. Water may be ruled out if extensive chemical treatment or special metals are required, or if its use results in considerable maintenance. Then too, provisions must be made for disposal of well water. This is usually important since the heat pump is a once-through type system and in some installations large quantities of water are required. Usually it is permissible to discharge to sewers or to an exhaust well. Some larger cities may have restrictions preventing discharge of large quantities of water to sewers.

Air seems to be the most inviting and offers the best possibility for a universal heat source for the heat pump. The fact that the source of heat diminishes as the heat requirement increases, combined with the possible wide fluctuation in outside air temperature, necessitates more careful designs than with well water.

Equation (1) shows that the coefficient of performance decreases as the heat source temperature is reduced. In using coils to absorb heat from the outdoor air at temperatures below 32F, some difficulties may be experienced with the defrosting of coils. Where frost accumulation is not too severe, reversing the cycle is satisfactory. If much ice has collected, this method is not too good. A method of spraying a non-freeze solution on surfaces to prevent frost accumulation has been developed in the last few years and offers a possibility for use on this type of installation.

Usually when the heating design temperature is approximately 45F or above, air can be used quite successfully as the heat source. To obtain economical and satisfactory operation using air at temperatures below 45F approximately, requires auxiliary source of heating or a storage system. When water is used as a heat source, however, the design temperature can be as low as is found in northern U. S. cities.

A disadvantage of a storage system is that equipment must be designed to provide excess heat during mild weather, which can be stored and used during the colder days. However, on some installations this may prove to be the most economical design.

In addition to the storage system, other possible sources of auxiliary heat for the designs shown in Figs. 3, 4 and 5, are abstracting heat from water, freezing water, and the use of straight electric and fuel heaters. Utilization of the latent heat of fusion of water offers a particularly good source of auxiliary heat if some means could be found for the disposal of the ice.

[redacted]

Design Temperature. Before the total heating and cooling load can be calculated, the design temperatures must be determined from available climatological data. Such data can usually be obtained from the United States Department of Agriculture and plotted similarly to that shown in Fig. 6. From these data a period should be selected which will represent the normal heating and cooling season. Thus, in the case of Fig. 6, if the assumption is made that the data are representative of the period from October to April, inclusive, + 5F can be tentatively selected as the design temperature for heating. However, there is a possibility that while the temperature will drop below this on a portion of eight days, the daily average temperature would only be below this once for a period of approximately two days. Since the times that the temperature dropped below 5F were rather sudden and of short duration, the most economical design seems to use 5F for the basic design and provides, if necessary, an auxiliary heating unit for the times that the design temperature is exceeded and additional heat is required. It would be uneconomical to oversize the equipment just to satisfy low outside temperature which occurs rather infrequently during the heating period. Similarly a study can be made of the cooling season to determine the required design temperatures for the cooling cycle.

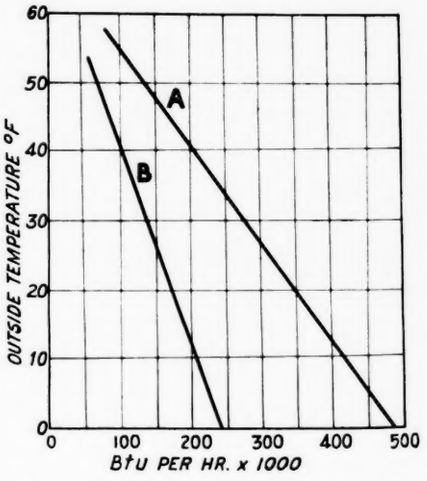


Fig. 7. Temperature-load chart showing comparison of no-insulation design (A) as compared with an insulated design (B).

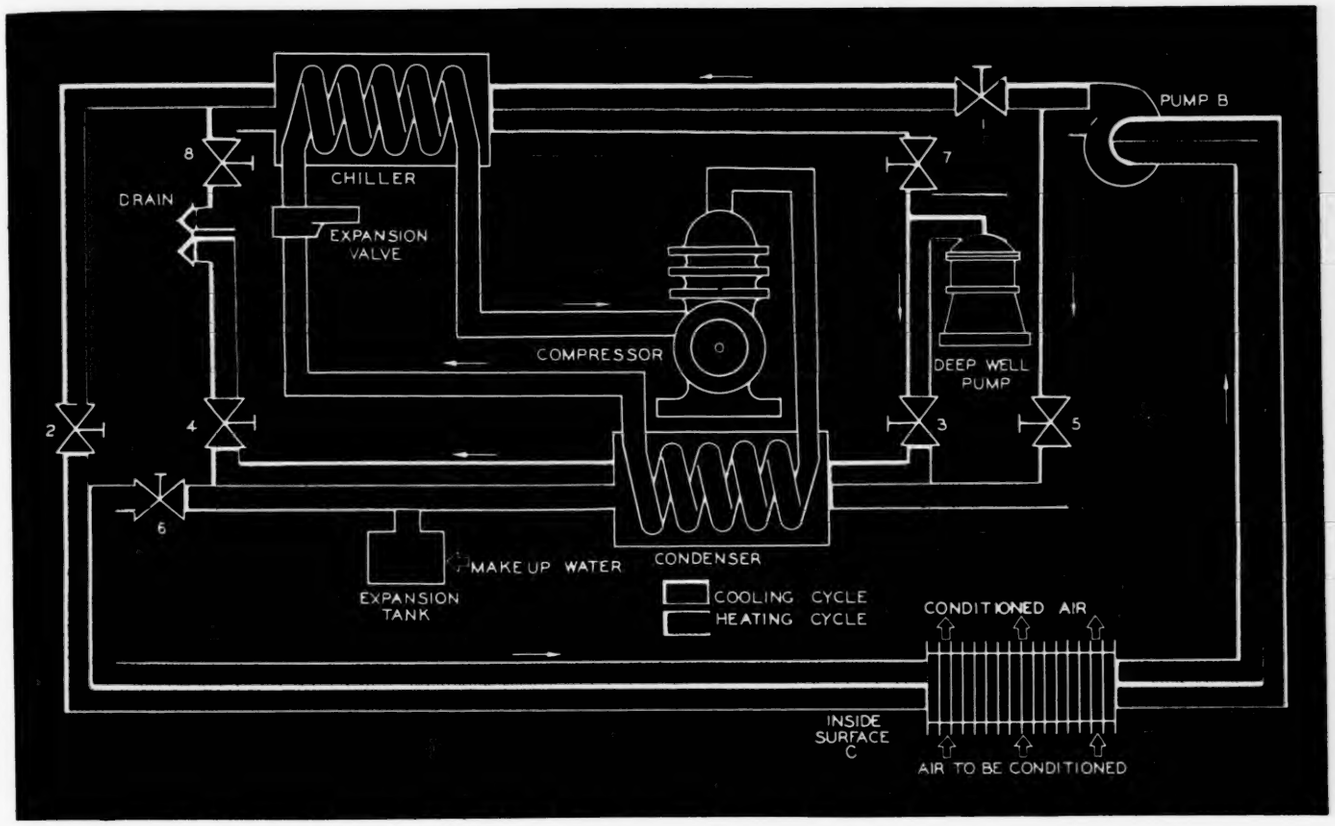


Fig. 8. Water-to-water type heat pump with water as source of heat and also as medium to transfer heat from condenser and chiller.
POSITION OF VALVES.—Cooling Cycle: Valves Open 1, 2, 3, 4; Valves Closed 5, 6, 7, 8;
Heating Cycle: Valves Open 5, 6, 7, 8; Valves Closed 1, 2, 3, 4.

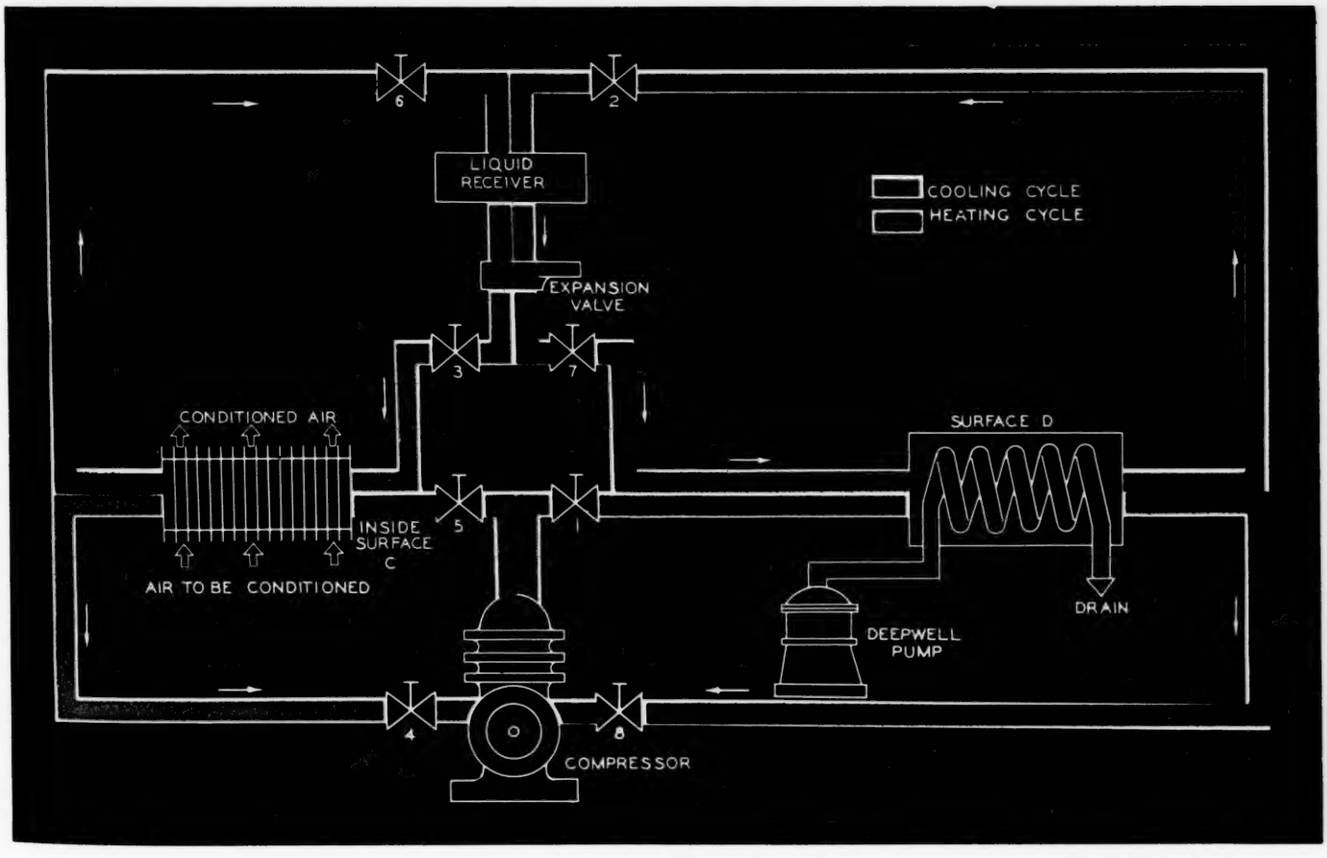


Fig. 9. Water-to-air design heat pump with water as source of heat and air to transfer heat from inside surface.
POSITION OF VALVES.—Cooling Cycle: Valves Open 1, 2, 3, 4; Valves Closed 5, 6, 7, 8;
Heating Cycle: Valves Open 5, 6, 7, 8; Valves Closed 1, 2, 3, 4.

Load. Usually the design of a heat pump can at least be started on the hypothesis that the refrigeration equipment will be sized to meet the cooling requirements with the use of supplementary equipment for any additional heating. In this regard consideration should be given to possibilities for making the cooling and heating requirements as nearly equal as possible so that use of supplementary heating equipment can be kept to a minimum, or eliminated entirely.

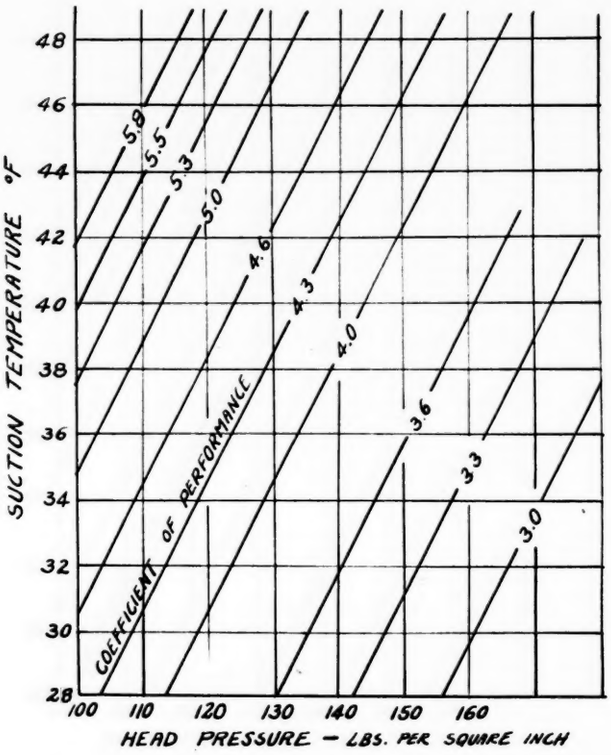


Fig. 10. Effect of head pressure and suction temperature on the coefficient of performance of a heat pump. Coefficient of Performance = (Condenser Output + Machinery Losses) ÷ Electrical Input to Compressor, all in Btu per hr.

Fig. 7 shows how this balancing can be brought about to a considerable extent by using insulation to reduce the heat loss and heat gain of the structure. In the case of curve *A* of Fig. 7, it was assumed that no insulation was used while curve *B* was based on using 2-in. of insulation on the roof, 1-in. on the side walls and employing double glazed windows. It can be noticed that the 480,000 Btu per hr heating requirement of the uninsulated structure at 0F outside temperature is reduced to 245,000 Btu per hr when insulation and double glazed windows are used. The cooling load for the structure was calculated to be 340,000 Btu per hr without insulation, and 225,000 Btu per hr when using insulation and double glazed windows. Usually the cooling requirements are not reduced in the same proportion as the heating requirements because of the internal heat gain which is independent of the structure.

Performance. In the design of a heat pump an attempt should be made to make the installation as simple as possible, using standard refrigeration equipment. The compressor and the heating and cooling surface combination should be selected to operate at the lowest head pressure and the highest refrigerant temperature to obtain the maximum coefficient of performance. Fig. 10, based on manufacturer's data, illustrates how the performance coefficient is affected by the working pressure of the compressor.

Referring to Fig. 10, it can be seen that the lower the head pressure and the higher the refrigerant temperature, the higher the coefficient of performance. However, the heating surface selected, which in turn determines the operating head pressure of the compressor, is dependent to a great extent on the allowable temperature which can be used for the conditioned space. If the heating surface is operated at too low a temperature, its area may become excessive and the air quantity being circulated to the conditioned space too large. This results in a large circulating fan and fan motor. On the other hand, selecting the heating surface to operate at too high a temperature, resulting in a high compressor operating pressure, will lower the coefficient of performance.

The minimum allowable discharge air temperature into a conditioned space depends on quite a number of factors. If the structure is well insulated and has double-glazed windows, a lower discharge temperature would be permitted than would otherwise be possible. Good practice is to start the design on the assumption that the air flow will be determined by the cooling requirements. Usually this results in the most economical and satisfactory heating cycle. It is obvious that the auxiliaries should be selected to operate at their maximum efficiency; this means that the reversing valves and connecting piping should be sized for minimum pressure drop consistent with sound operating economies.

Controls. Control of the heat pump system is important. There are many methods of control ranging from manual to completely automatic operation. Either an electric, a pneumatic or a combination electric-pneumatic control is applicable to a heat pump. Obviously the minimum amount of control equipment should be used to achieve the operation and performance desired. Sufficient safety controls should be incorporated, however, to prevent excessive head pressure and objectionable low refrigerant temperatures. Usually in designs using outdoor air as the heat source, additional controls must be incorporated because, as the outdoor temperature rises, the available capacity increases and the heat requirements decrease. Provisions are then required for capacity regulation to prevent overloading the compressor motor.

Coefficient of Performance. Before the design is considered complete, and all the equipment finally selected, it is a good plan to calculate the coefficient of performance by the use of equation (2) in order to determine if the efficiency of the system is satisfactory:

$$\text{C.O.P.} = \frac{\text{Output (Btu per hr)}}{\text{Input (heat equivalent of electric energy used), Btu per hr}} \quad \ldots (2)$$

As an example, assume that the equipment was selected for a system patterned after Fig. 9 (water to air design) to satisfy a heat gain of 225,000 Btu per hr. The compressor during the heating cycle was selected to balance at 120 lb per sq in head pressure, 40F suction temperature, when delivering 270,000 Btu per hr and requiring 15.4 kw electrical input. A 3 hp deepwell pump was selected requiring 2.3 kw. The coefficient of performance in this case is

$$\text{C.O.P.} = \frac{270{,}000}{(15.4 + 2.3)\ (3415)} = 4.45$$

Designs in which surfaces have a dual-role of being used both as a cooling coil or evaporator and heating coil or condenser, require more careful analysis than the design using a fixed refrigerant circuit. Because surfaces are dual purpose does not mean that special coils are required, but only that care must be used in their selection control.

This discussion of factors influencing the design is not intended to cover the method of selecting equipment, since this is covered in many handbooks and manufacturer's publications. The chief purpose is to

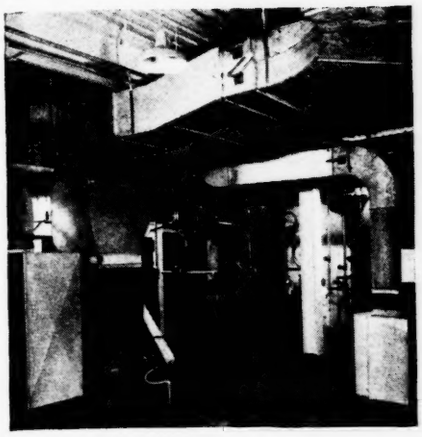


Fig. 11. (Above) Two 20-hp G-E compressors are used in the air-to-air heat pump for the Steubenville, Ohio, building shown in Fig. 12 (Right).

show that (1) the designing of a heat pump differs very little from a conventional refrigeration system, (2) the importance of selecting equipment to give the most economical heating-cooling combination, and (3) the effect of equipment selection upon the coefficient of performance when heating.

Accompanying photographs show some of the buildings located on properties of the electric utilities that have heat pump systems, with which the authors are associated.

Figs. 11, 12 and 13 show the building and equipment of the heat pump installation on the property of The Ohio Power Company, Steubenville, Ohio. This system falls in general classification of air to air design, Fig. 3.

This office building of two stories and a basement has an approximate volume of 170,000 cu ft. The walls are equivalent to 11-in. brick and 1½-in. of insulation. The steel deck roof has 1-in. insulation and all windows are double glazed.

Two 20 hp General Electric refrigerating compressors complete with inside surface, outside surface automatic changeover valves, and automatic control are installed. The outside surface, shown in Fig. 13, is on the roof. The inside surface and compressor are located in the basement. A storage tank is incorporated in this design. One of the 20 hp compressors heats the building when outdoor temperature is 25F or above. The other 20 hp unit heats and maintains the water in the 4,500-gal tank at 110F when the outdoor temperature is between 25 and 40F. When outside temperature is between 15 and 25F, both compressors are used to heat the building; below 15F the 110F water is circulated through a booster coil by means of a pump. A 15 kw electric immersion heater is installed just ahead of the circulating pump which heats the water going to the booster coil from 110F to 160F when the outdoor temperature falls below 5F.

No actual performance tests have been made on this installation, but calculations show that the system should have a coefficient of performance of 3.25 on a 0F day and 3.7 on a 50F day. If losses from motors, belts, compressor, etc., are considered as non-useful heat, the coefficient of performance drops to 2.9 on a 0F day and 3.2 on a 50F day.

During periods when the outdoor temperature is below 32F, ice slowly forms on the outdoor surface. This surface was so designed that a considerable amount of ice could collect on the surface before the operation of the system would be affected. The outside surface is defrosted by manually reversing the cycle of operation so that the hot gas goes first to the outdoor coil.

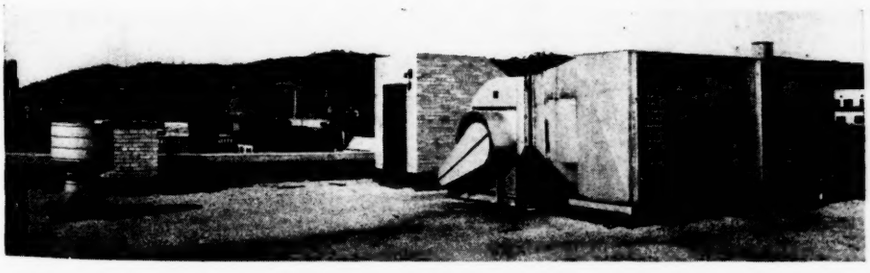


Fig. 13. At Steubenville the outside heat transfer surface is on the roof.

Figs. 14 and 15 show the building and equipment of the heat pump installation on the property of Kentucky and West Virginia Power Company, Inc., Pikeville, Kentucky. This type system falls in the classification of water to air design (Fig. 9).

This two-story office building has a volume of approximately 120,000 cu ft. Outside walls are equivalent to 11-in. brick and all windows are double glazed. Two inches of insulation was applied to all outside walls and the roof.

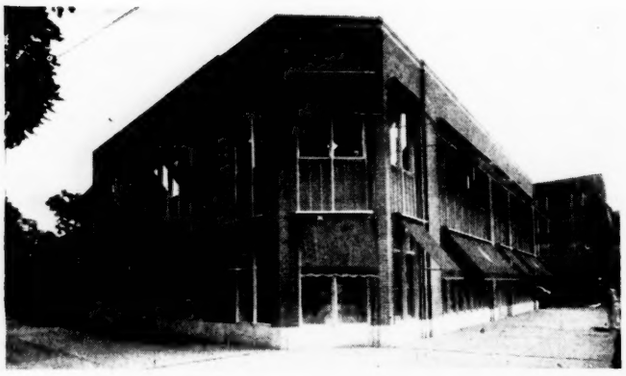
The 20 hp Frigidaire refrigerating compressor, complete with the inside surface, water to refrigerant heat interchanger, the deepwell pump, reversing valves and automatic control, are located in the equipment room in the first floor level. Reversing of the refrigerant cycle to give cooling or heating is automatic in response to an outdoor thermostat.

Based on several tests of short duration, the estimated average coefficient of performance of this system, including the electrical input to the deepwell pump, is 3.2.

Figs. 16, 17 and 18 show the building and equipment of the heat pump installation on the property of the Atlantic City Electric Company, Pitman, N. J. This system, too, falls in general classification of water to air design (Fig. 9).

This building of two stories and a basement has a volume of approximately 59,000 cu ft. Outside walls are equivalent to 12-in. brick with 2-in. of insulation. The roof has 2-in. of insulation and the windows are single glazed throughout.

A 2-speed, 15 hp York refrigerating compressor complete with the inside



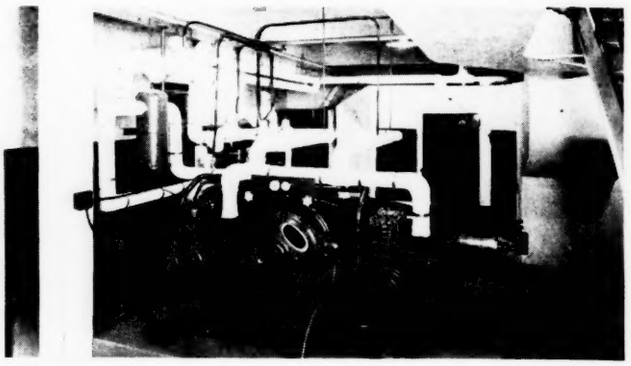


Fig. 14. (Left) The Pikeville, Ky., office building of the Kentucky and West Virginia Power Company, air conditioned by a water-to-air type heat pump. Fig. 15 (Right) The 20-hp Frigidaire refrigerating compressor in the Pikeville system.

surface, water to refrigerant heat inter-changer, the deepwell pump, reversing valves and automatic control, are located in the basement. Reversing of the refrigerant cycle to give cooling or heating is automatic in response to an outdoor thermostat.

Design of this system is such that during the heating cycle the compressor transfers heat taken from the well water by means of the cooler, to the condenser where it is dissipated to the air that is delivered to the conditioned space. During the cooling cycle, the condenser becomes the evaporator and the water cooler becomes the condenser.

A deepwell pump supplies approximately 30 gal per minute of 57F water which, after going through the system, is discharged into the city sewer.

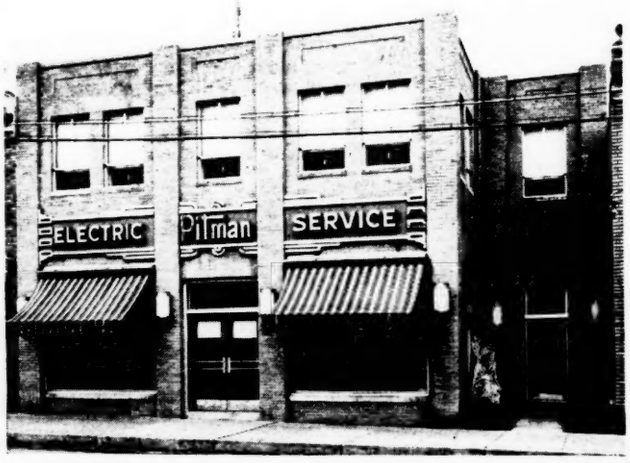
Figs. 19 and 20 show the office building and heat pump installation on the property of the Appalachian Electric Power Company, Logan, W. Va. This system falls in general classification of water to air design.

This building of three stories and a basement has a volume of approximately 114,000 cu ft. The average wall construction is equivalent to 12-in. brick with 4-in. of rock wool insulation. The roof has 4-in. of insulation and all windows are single glazed.

This building contains offices and an auditorium seating 100 persons. Due to the possibility of variable auditorium load, causing the heating and cooling requirements for the two spaces to be entirely different, two individual supply units were installed, connected in parallel to one refrigeration system.

This system was installed in an existing building. Due to type of building construction it was not feasible to provide for proper space zoning. However, it was necessary to provide some means of temperature control since part of the space has little outside exposure while other sections have double exposure. A heat pump system was installed to handle the base load, heating the fresh-recirculated mixture to 65F. In addition, electric strip heaters were installed back of each supply outlet to take care of the variation in heating requirement between different parts of the structure.

The refrigerating system consists of two 15 hp Carrier Corporation units, complete with inside surfaces, water to refrigerant heat exchangers, deepwell pump, reversing valves and automatic controls. The two inside supply units, each equipped



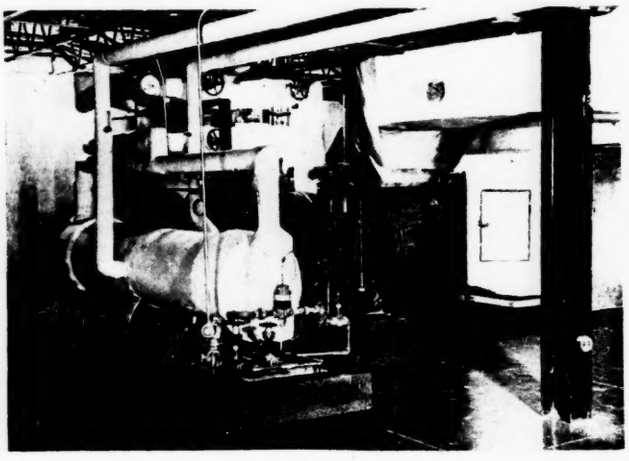
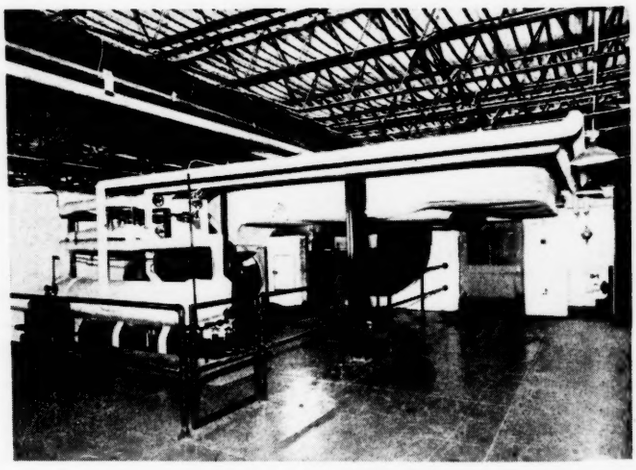


Fig. 16. (Left) Pitman, N. J., office building of the Atlantic City Electric Company, air conditioned by a water-to-air type heat pump. Fig. 17. (Left, below) Two-speed 15-hp York refrigerating compressor in the Pitman installation. Fig. 18. (Right, below) Basement of the Pitman plant showing simplicity of job.



with circulating fans, heating-cooling surface, and filters, complete with connecting piping, are shown in Fig. 20.

A deepwell pump supplies approximately 100 gpm of 60F water which, after passing through the system, is discharged to a nearby river.

Refrigeration equipment and operation of this heat pump are similar to that installed at the Kentucky and West Virginia Power Company, Inc., office building, Pikeville.

[redacted]

A ½ hp heat pump unit has recently been developed which can be used to cool a limited space in the summertime and heat it during colder weather. Since this unit employs outdoor air as the source of heat during the heating cycle, its heating capacity is reduced as the outdoor air temperature drops. Nevertheless, such a unit can be used quite economically to heat offices or rooms in localities where only moderately cold temperatures are experienced or even in more severe climates during the fall and spring seasons when part time heating is required. This may be during early mornings and late afternoons and when either no heating is required the remainder of the day, or when perhaps even a moderate amount of cooling can be used. The unit is illustrated in Fig. 21.

[redacted]

Basically, the advantages of the heat pump as a year-round air-conditioning system are so numerous that they entirely outweigh the small number of disadvantages. On the credit side there are:

Health and cleanliness. Since no combustion takes place and no products of combustion are generated, the problem of their disposal is eliminated. The need for a chimney is automatically eliminated. Cleanliness is promoted by the absence of products of combustion and associated soot;

Economy in cost of installation. By combining heating and cooling in the same equipment, it is possible to improve the economics of both cycles;

Compactness. The combination of heating and cooling in one system results in minimum use of space;

Flexibility in arrangement. The location of equipment is not fixed. It can be on the roof, in the basement, and in fact in almost any part of a building;

Quickness of response. Heat pump equipment has a natural quick pick-up in response to outdoor temperature changes;

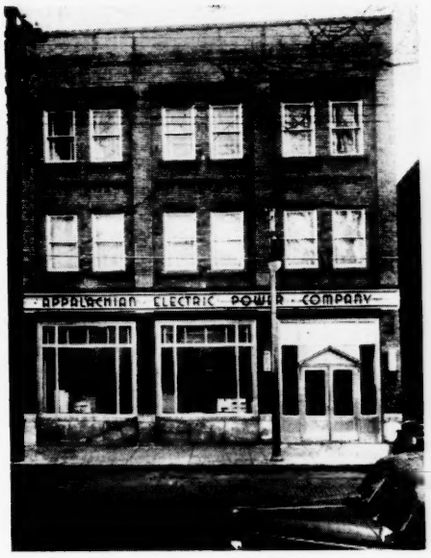


Fig. 19. Office building of the Appalachian Power Company, Logan, W. Va., air conditioned by a water-to-air type heat pump.

Concentration of utility services. By combining heating and cooling requirements into an all year-round single system, it is possible to arrange the building to operate on a single electric utility service. Thus, the need for gas and/or oil is automatically eliminated.

On the disadvantage side can be mentioned the following:

Common faults of the conventional refrigeration system. Some of these faults are expansion and solenoid valve failures, failure of compressor parts and refrigerant leaks. These, however, are bound to be of a temporary nature, since great strides have already been made in refrigeration equipment, which are equally applicable to a heat pump system. Further improvements will result with the development of markets for such equipment. It is possible, therefore, to look forward to a time in the near future when heat pump equipment will operate with a small or negligible amount of maintenance;

Lack of a universal heat source. This would appear to be a definite handicap, but air as a source of heat is available in areas in which the majority of the vast United States population is centered. Therefore, in this country, at any rate, it should be no major barrier. In addition, sources of heat other than air, such as water, can be developed in many areas that do not adapt themselves to the use of air.

[redacted]

Equipment and installation costs of a heat pump do not compare unfavorably with the cost of a conventional year-round heating and cooling system. However, if a moderate amount of the total cost is not allocated to cooling, the first cost of a heat pump would not compare favorably with a conventional heating system; however, there is no reason why a heat pump which supplies heating and cooling should compare favorably with a system supplying heating only.

If a full development program were carried through and manufacturing done on a quantity basis—or better yet on a mass production basis—there appears to be little question that the first cost of a heat pump installation could be brought down to the point where it would come within the means of the average typical middle class house. As a matter of fact, it is surprising how little development work has been done on the heat pump, considering the tremendous potentialities from a commercial and social utilitarian point of view.

A comparison of the operating cost of a heat pump with a conventional system is rather difficult because operating cost in a conventional system is quite variable, depending upon the type of fuel used, type of equip-

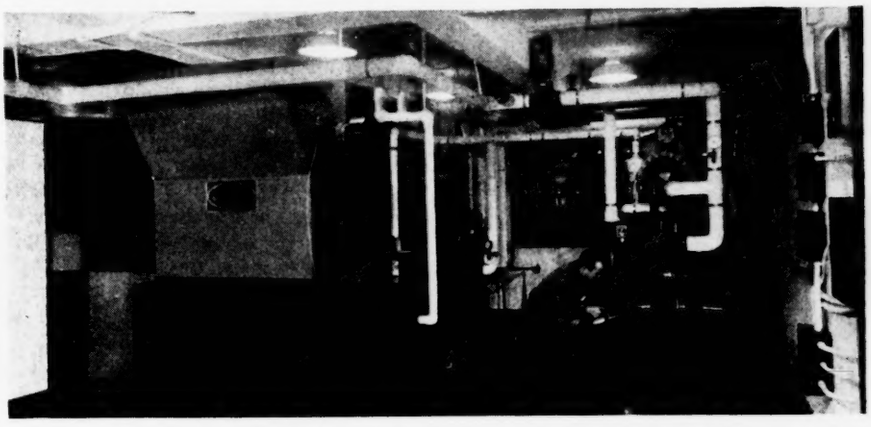


Fig. 20. Two 15-hp Carrier compressors are employed in the Logan installation.

TABLE 1. COMPARISON OF EQUIVALENT COST OF HEAT BY HEAT PUMP AND BY FUELS

Cost of Electrical Energy per Kw-Hr, Cents	Cost of Fuel on Equivalent Output Basis				
	Coal, per Ton		Gas, per 1,000 Cu Ft		Oil, per Gal
	12,000 Btu per Lb	14,000 Btu per Lb	550 Btu per Cu Ft	1,000 Btu per Cu Ft	125,000 Btu per Gal
1	$10.20	$11.90	$0.234	$0.424	$0.052
1½	15.30	17.85	0.351	0.636	0.078
2	20.40	23.80	0.468	0.848	0.104

Assumed: Coefficient of performance of heat pump = 4.5
Efficiency of conventional heating systems = 65%

ment employed, and the care with which it is operated. Nevertheless, it is interesting to show even roughly a comparison of the two systems. For this purpose, Table 1 has been compiled to show the cost of three different classes of fuel when compared with the output from a heat pump at three different costs of electrical energy.

Under conditions assumed, that is, a coefficient of performance for the heat pump of 4.5 and an efficiency for the conventional heating system of 65%, the heat pump using electric energy at 1 cent per kw-hr is fully competitive from an energy output standpoint with 12,000 Btu coal at $10.20 and with 550 Btu gas at 35.1c. But it is important to point out that the cost or trouble of attendance, rather than the cost of fuel, has an important bearing in the operation of the coal-fired heating system in many buildings. This is borne out in many houses that are today being heated by manufactured gas at costs in excess of the highest figure employed in the above table and these houses are finding it advantageous because of the elimination of attendance costs and troubles when using gas fuel. It is obvious that under corresponding conditions the heat pump would have the same advantage. While this analysis admittedly considers only some of the phases of the competitive problem, it does clearly show that with a reasonable coefficient of performance, the heat pump with all its advantages can be brought on a full competitive level with older, less flexible sources of heat.

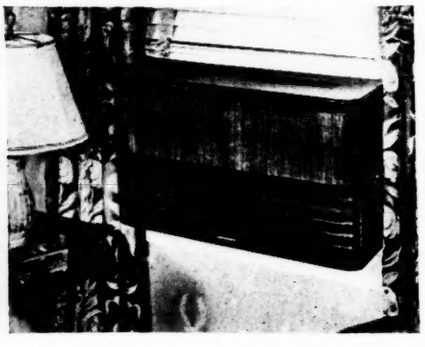


Fig. 21. Westinghouse Mobilaire, a self-contained reverse cycle refrigerating unit.

The discussion and illustrations of the basic designs of the heat pump show that this type of year-round air-conditioning system is economical and practical when designed in accordance with good engineering practice. Experience with a large number of installations located in office buildings of electric utilities, with which the authors are associated, definitely shows that satisfactory operating results can be obtained.

In spite of the many obvious advantages of electric heating, there are very few areas in this country where straight electrical heating has taken hold or can be justified when the relative cost of delivered electrical energy is compared with the corresponding cost of coal, oil, gas or other fuels. The reasons for this are:

(1) Electrical energy is most commonly obtained from conversion of heat energy into mechanical-electrical energy. The most modern steam plant has, however, a conversion efficiency of only 34%. Taking transmission-distribution losses at 15%, this gives a converted percentage of the original heat content of 29%. This compares with a probable percentage recovery in direct fired installations of 60%; and

(2) The cost of electrical distribution acts as a barrier to reduction in price of electrical energy to a sufficiently low level to be competitive with fuel generated heat when the quantity of electrical energy required is determined by a straight 1:1 energy conversion from the electric to heat form.

The heat pump offers the best practical means of eliminating the thermodynamic handicap that electrical energy is under in any attempt that it may make to enter the residential or commercial building heating field. By supplying a small amount of motive energy, it takes heat which can be removed from an outside source and raises it to a high enough level to make it possible to heat a structure.

The development of the year-round electrical load is important to the building owner or occupant, to the air-conditioning industry and to electric utilities because of the great role that refrigeration equipment is bound to play in tomorrow's buildings. Cooling equipment sales are today handicapped by the general short use period in the average building; too, it is a difficult load to serve economically by the electric utilities for the same reason. The heat pump, however, offers the possibility of a year-round air-conditioning system with the maximum economy in the use of refrigeration equipment since the same equipment that is utilized to heat in the winter can be used to cool in the summer. This feature makes it an ideal electrical load for the utility to serve on an economical basis. Thus, the heat pump offers the best practical means to make the much talked of all-electric building a reality.

Some Heat Pump Installations which Have Been Publicized in the Technical Press

1. United Illuminating Company Administration and Service Building, New Haven, Conn.
   Water to water design. Eight 40 hp Westinghouse units; use approximately 400 gpm of 55F well water.

2. "Cine Novedades" Moving Picture Theatre, Buenos Aires, Argentine.
   Water to air design. 50 hp refrigerating compressor unit; 88 gpm of 64-68F well water is used.

3. The Ohio Power Company Office Building, Portsmouth, Ohio.
   Air to air design; two 25 hp General Electric units.

4. The Ohio Power Company Office Building, Coshocton, Ohio.
   Water to water design; one 10 and one 15 hp Westinghouse refrigerating compressor.

5. Atlantic City Electric Company, Salem, N. J.
   Water to air design; four 5 hp General Electric refrigerating compressors.

What the Ventilating Engineer Should Know About Lead

Certain metals, gases and liquids affect the health of those who work intimately with them unless precautions are taken. The ventilating engineer is particularly concerned with those substances whose undesirable effects can be mitigated or eliminated by some form of ventilation, and for that reason background information on benzene, hydrogen sulfide, carbon disulfide, cadmium, and carbon monoxide has been presented in various past issues. The accompanying article on lead is an abstract of an article by May R. Mayers, M.D., of the Division of Industrial Hygiene, New York State Department of Labor, and which appeared serially in "The Industrial Bulletin" of the Department.

LEAD is absorbed into the body primarily by inhalation of air containing lead dust or lead vapors. Lead may also enter the body by way of the gastro-intestinal tract as a result of ingestion. Only tetraethyl lead is absorbed through the skin in significant amounts.

Lead Ingestion — The larger part of the lead which enters the stomach is not absorbed but passes through the gastro-intestinal tract without injury to the body and is eliminated in the feces. The remainder of the lead is absorbed into the portal circulation which carries it to the liver. Three things may happen to lead which reaches the liver: (1) Part of it is stored in the liver; (2) Part of it is excreted into the feces by way of the gall bladder; and (3) A third part passes through the liver into the general circulation and is either stored in the bones or other tissues of the body, or is excreted by the kidneys into the urine. Usually both of these things occur.

Lead Inhalation—Lead in the air which a worker breathes is inhaled and is carried to his lungs. From there it is absorbed directly into the general circulation. For this reason lead which is inhaled is, in general, more dangerous than lead which is swallowed. None of it can be excreted without first being absorbed.

Lead Storage—After lead has been absorbed into the general circulation (regardless of the precise way in which it had originally entered the body) it is carried in the blood stream to all parts of the body. The liver and muscles are next in importance to the bones as storage warehouses of soluble lead. Lead may also be deposited in the gums, forming the familiar "lead line." When active lead absorption ceases, there is a tendency for the lead to be mobilized from the many points where it had been deposited and transferred for more permanent storage to the bones.

Without attempting to describe even briefly the complex and often extremely confusing clinical entity known as lead poisoning, a few highspots believed to be of practical value will be discussed.

Occupational History—First, it is of the utmost importance to obtain a clear-cut history of exposure to lead. It is important to determine not only whether the patient was working with lead for a period immediately preceding the onset of the present illness but to go back over previous occupations to determine whether there had previously been any significant lead exposure since lead storage in the body at that time may have a bearing on the clinical picture being investigated.

Clinical History—Since lead, which is absorbed, is carried in the blood stream to all parts of the body it is evident that a great diversity of symptoms may result, depending upon the tissues or organs involved. And these symptoms need not necessarily differ in any respect from those produced by other organic disease of these same tissues or organs. In order, therefore, to determine whether or not symptoms complained of by the patient are due to lead, an extremely careful and complete clinical history is essential and this must be carefully correlated with the occupational history, with subsequent findings on physical examination and with the results of laboratory tests, before a differential diagnosis can be made.

Lead Absorption and Lead Poisoning — Having established the fact that the patient had been exposed to significant amounts of lead, it is necessary to differentiate between lead absorption and lead poisoning, recognizing all the while that when absorption reaches the point where signs and symptoms of clinical disease begin to manifest themselves one is dealing with lead poisoning. In the absence of clinical disease, however, there may nevertheless be definite lead absorption as evidenced by the well known lead line in the gums, for example; increased lead in the blood; or excessive lead excretion in the urine or feces. While, in and of themselves, these findings point only to lead absorption, they acquire added significance when associated with signs and symptoms in that such evidence of significant lead absorption may materially assist in a differential diagnosis between lead poisoning and other disease entities presenting similar clinical syndromes.

The term lead "poisoning," thus applies to the clinical disease entity resulting from absorption of lead into the body in amounts which the body is unable to cope with in a normal manner. Whether or not there is actual disease will depend upon the amount of lead absorbed. Whether or not there is disability will depend upon the extent of the intoxi-

cation or the specific organs or tissues involved in the particular case.

Among the early clinical manifestations of lead poisoning are constipation, loss of weight and appetite, ashen pallor unrelated to any anemia, lead line in the gums, subicteric sclerae and sometimes tremor and a transitory rise in blood pressure. Clinical entities such as lead colic or wrist drop will usually develop later unless the exposure has been to high concentrations of lead. Nervous manifestations of any kind whatever in a lead worker should be looked upon with suspicion and be promptly and thoroughly investigated. Increased nervous instability or insomnia may herald an impending encephalopathy. Prompt recognition of early clinical manifestations of beginning lead intoxication will usually make possible the prevention of more serious disease.

A more detailed discussion of the very complicated clinical entity known as lead poisoning is obviously impossible here. There is a large volume of literature on the subject readily available to anyone interested.

Prevention of Lead Poisoning†

This may be accomplished by the application of a few simple fundamental principles as follows:

Safe Exposure Limits—It has been estimated by authorities on the basis of a wide experience that if the amount of lead in the air of a workroom is kept below 1.5 milligrams per 10 cubic meters of air for continuous exposure lead poisoning will not occur, excepting perhaps in very rare individuals with unusual susceptibility.

Good Housekeeping—Good housekeeping is perhaps the simplest and most effective single means of reducing lead exposure in lead plants. This involves the daily removal, by washing or vacuum cleaning, of all lead dust generated in the course of each day's work. Such cleaning operations should be conducted whenever possible, at the end of the day, after the workers have left the workroom. Furthermore, all persons doing the cleaning up should be provided with suitable respiratory protection. Lead and lead dust which is permitted to remain on work benches, day after day, will fall on the floor; be ground under foot and will be an ever-present source of significant amounts of lead in the air breathed. The same is true of lead dust on shelves, ledges or other parts of the room; lead on hand tools, utensils, etc., all of which should at all times be kept scrupulously clean. No amount of expensive ventilation will make up for fundamental deficiencies in good housekeeping. Insofar as possible, therefore, walls, floors and workbenches should be constructed of good smooth and impervious materials which lend themselves to being kept clean.

Good housekeeping, however, implies even more than daily washing or vacuum cleaning of floors, workbenches, tools, equipment and other items where lead dust may accumulate in the course of the day's work. It includes such matters as providing special storage rooms for stocks of lead so that they will be kept off the floor of the workroom; providing a sufficient number of covered waste receptacles along workbenches and elsewhere to receive waste scraps of lead, so that they do not find their way to the floor of the workroom; separation of workrooms in which lead materials are handled from adjoining rooms so as to confine the lead to limited parts of the plant where control measures can be concentrated.

These are only a few items under the general heading of good housekeeping, but suggest the general line of approach. Good housekeeping is the essence of control.

General Safe Practice — Insofar as practicable, lead processes should be entirely enclosed and completely mechanized. Discharging of a batch of lead or lead compounds by dumping; hand shoveling of lead compounds or scooping up lead compounds by hand scoop in weighing operations should be replaced by mechanized processes wherever possible. Machinery in which lead materials are processed should be so constructed that no lead dust or fumes will escape into the breathing atmosphere of the workroom during its operation. All such machinery should, moreover, never be opened until the dust has had an opportunity to settle and the machinery has had time to cool down.

Wet processes should wherever possible supplant dry ones. Even socalled "semi-wet" processes such as one sees in grinding or smoothing of lead materials by means of stone mills should be carefully controlled because the water tends to evaporate, leaving a dry dusty sediment on the stones which may be blown around in the air of the workroom.

Whenever possible less toxic substances should be substituted for lead.

These are only examples.

Ventilation—Attention is directed to the general principle that all lead processes generating lead dust or fumes should be provided with properly designed and adequate local exhaust ventilation.

Lead should never be heated to a temperature above 450F without proper hood and exhaust ventilation.

Periodic air analyses at strategic points in a lead plant should be a routine procedure, when possible, in order to be sure that the concentration of lead in the air does not exceed 1.5 mgm per 10 cubic meters of air for continuous exposure.

The maintenance of good general hygiene in a lead plant is usually the function of the plant manager or superintendent rather than that of the plant physician. However, the ultimate responsibility should be the physician's and he should supervise and consult with the persons directly assigned to this work.

†EDITOR'S NOTE: Dr. Mayers' complete article discusses three phases of lead poisoning prevention—reducing the exposure, here abstracted; personal hygiene, and medical care. The last two are not of particular concern to the engineer and hence are not included in this abstract.

WASHINGTON NEWS

Summarized by Loring F. Overman. Fuel Conservation Plan Proceeds; Reconversion Plans Are Under Way; A. C. Section Has Been Reorganized.

What does 1944 hold for the heating, ventilating and air-conditioning industries?

What will the coming year mean for the engineers, architects and consultants who adapt the industries' products to the current need?

From the Washington vantage point, a sharp change of pace is indicated, accompanied by a number of problems non-existent when the war effort virtually took over the plant and personnel of the entire air-conditioning field, lock, stock and barrel.

The need for a pace change stems from the obvious—victory in Europe in 1944 is predicted by no less an authority than the supreme commander of the invasion forces, General Eisenhower. "When in 1944?" is still an unanswered question, but it is no secret in Washington that the gigantic invasion craft program calls for completion of deliveries "in March." Completion of this program, with its tremendous demand for sheet and plate steel, should just about wind up the last noticeable shortage in the steel production program, making available for the first time since 1941 some of the type of metal necessary to civilian production of heating, ventilating and air-conditioning equipment.

Except for plate steel going into the wind-up phases of the ship-building and invasion-craft programs, there are few shortages in the metals set-up—copper and aluminum already having reached a point where some releases for civilian use have been authorized, while others are in the making.

Cut-backs Significant

With the factories and the professional personnel of the heating and air-conditioning industries still working overtime to keep pace with present military requirements, it may prove difficult to take time out to plan "pace changes." The vital need for such advance planning is apparent, however, in the War Department's latest forecast of 1944 requirements, as released by Maj. Gen. Lucius D. Clay, director of materiel, Army Service Forces.

Next year's heaviest emphasis, Maj. Gen. Clay reports, will be on ships, planes, heavy-construction machinery and signal materiel. The Army construction peak was reached last July, and no new construction will be undertaken unless present facilities, some of them now idle, cannot be converted to meet the need.

Overall tank production has been cut back 36 percent since early 1943. Several small arms ammunition plants have been closed recently and this entire program is now tapering toward a decline of about 36 percent dollar volume, from 1943. Production of rifles is being reduced to a level 30% below the November peak. Production of artillery weapons and ammunition, particularly of the sizes for anti-aircraft defense, has been cut back 50%.

General Clay said production of 90-mm anti-aircraft guns has been cut to one-twelfth of the maximum; 4.7-inch and 40-mm guns to one-half maximum. Three government arsenals and 12 private companies have discontinued the manufacture of 90-mm guns and programs at 16 other companies have been cut back.

Conversely, production of aircraft and trucks will increase materially; heavy construction machinery and landing mats will be in demand, and Signal Corps equipment tied in with aircraft programs will expand. The Medical Department will reduce its program in all branches except production of blood plasma, and in Chemical Warfare the emphasis will be placed on incendiary bombs and smoke material.

Re-Conversion Ahead

The foregoing summary of expansions and cutbacks contains food for thought for those in the heating, ventilating and air-conditioning industries. It points out where equipment is to be needed; where its use is to be discontinued, and, most important—which industries are to take the lead in re-conversion. Obviously, each of the plants in which war materiel cut-backs are taking place will lay claim to a share of released materials for civilian production.

Right now the War Production Board, working with the Office of Civilian Requirements, is scanning all of the "L" and "M" Orders (the Limitation and Conservation Orders), for the purpose of easing restrictions as fast as the materials picture changes, and as rapidly as the manpower situation will permit scheduling of civilian production in a given area.

The plan now is to release materials to plants in areas where manpower supply is sufficient to permit re-conversion without interfering with any phase of the war program. This indicates that permission to start producing a given civilian item may be granted plants in slack labor areas, but may be withheld from similar industries in areas where labor shortages exist. A gradual easing of the manpower situation is likely, however, with military forces releasing between 50,000 and 75,000 men per month—some serious casualties, but others fully capable of taking a productive place in civilian economy.

Blueprints Needed NOW

With the "L" and "M" Orders at the reconsideration stage, it is important that heating, ventilating and air-conditioning industries be ready with the blueprints of what they want to do when re-conversion time comes. For some, it should be remembered, re-conversion time is at hand. Within the next few weeks or months the heating, ventilating and air conditioning industries, through their WPB Advisory Committees, should be smoothing the way for quick action that will make it possible to pick up civilian production whenever war production declines.

At best, many will recall, Washington machinery moves slowly in revising conservation and limitation orders. Industries not ready with proposals, alternates, and compromises may find the delays of unwinding WPB even more hectic than the winding process.

Now is the time for market analysis throughout the entire industry. Where will the heaviest postwar demand occur? During the period when neither the materials nor the manpower can be released for complete re-conversion, what stop-gap products could be produced? Will the required components for such stop-gap products still be in demand by military forces? Can substitutions be made? How can those whose war production ceases first be kept going

without unfair postwar results for those whose products or services are still in demand by the military?

These are only a few of the problems ahead. Those past may prove simple by comparison, for they involved largely the adaptation of fixed principles to a new customer —Uncle Sam. Perhaps, however, this word of warning from a Washington observer to "study re-conversion now" is unnecessary. Industries which have planned and executed the miracle of war production have doubtless taken "time out" to chart with equal skill a re-entry into civilian fields.

Oil Transport Threat

As late as December 27, the Office of Defense Transportation issued a warning that difficulties were again looming in the domestic oil transportation front. Despite completion of the Big Inch crude pipeline and near completion of the Little Big Inch, ODT petroleum transport officials said that changing domestic conditions make it imperative that there be no let-down in the transportation effort. ODT listed three factors operating to increase the complexity of domestic oil transportation:

1. A disposition among shippers, receivers and railroads to assume that the tank car situation is easing.
2. The shifting of tank cars from solid trainload operations to many smaller runs in all parts of the country.
3. The serious shortage of over-the-road tank truck transportation due to severe shortage of heavy-duty tires and repair parts, the obsolescence of equipment and the shortage of manpower.

The ODT added that it is taking immediate steps to remedy this situation in conjunction with the Army and War Production Board. In extreme cases, the Army has drawn on its supply of parts and tires to restore to service some tank trucks which carry oil and gasoline to Army air fields.

Gas Order Changed

Revised designations of industrial and public consumers of manufactured gas who must receive preferential treatment from gas utilities were announced December 22 by the War Production Board. Changes in the listing bring the gas limitation order (L-174) into substantial accord with the list of preferred users of natural gas now contained in Utilities Order U-7. Revocation of General Directive No. 1 to L-174 was also announced. Elimination of this directive places gas consumers owning any type of standby equipment on an equal footing for purposes of curtailment in cases of gas shortages. Previously, those with coal burning equipment were the first to have gas deliveries reduced in such circumstances.

L-79 Being Revised

Because of the recent issuance of CMP-9-A, an order which authorized plumbing and heating repair men to acquire 60-day inventories of controlled materials, together with "such other materials as are needed to complete the repair," Limitation Order L-79 is being rewritten to replace Preference Rating Order P-84 in providing repair materials for the plumbing and heating industry. The need for revision arose when repair men asked whether the provision regarding "all other materials needed" was intended to include replacement boilers, furnaces and similar equipment. In general, the question was answered in the affirmative but order L-79 is being rewritten to state the conditions and prescribed necessary controls.

AC Section Reorganized

The Refrigeration and Air Conditioning Section of the WPB's General Industrial Equipment Division has been reorganized to give more time to direct work with manufacturers on procurement of materials and component parts, and the completion of specific programs established by various Government Agencies. Insofar as possible, the section will also provide assistance in developing permitted production of normal products to supplement the production of wartime products. Recently amended Order L-38, which eliminated a considerable amount of the routine processing of priority actions, has made this reorganization possible.

Manufacturers and others in the refrigeration and air conditioning industry are urged to present their problems to the staff of this section. A summary of the personnel and their respective responsibilities follows: Frederick W. Smith, Chief, Special Equipment Branch; Sterling F. Smith, Chief, Refrigeration and Air Conditioning Section, Administrator of Order L-38; Roderick H. Tait, Deputy Chief, Refrigeration & Air Conditioning Section, Administrator of Order P-126; F. B. Millham, Special Assistant to Branch Chief, Administrator of Order L-126 and Order M-28; A. Gordon Wootton, Chief, Material Coordinating Unit (CMP); J. F. Lambert, Technical Consultant to Material Coordinating Unit; Bert Meyer, Chief, Unitary Equipment Unit (Water Coolers, Self-Contained Air Conditioners and other similar equipment); A. H. Keeler, Chief, Compression Equipment Unit (Locker Plants, Cold Storage Warehouse Equipment, Ice Plants, and similar equipment); H. L. Forman, Chief, Commercial Refrigerator Unit (Reach-in and Walk-in Refrigerators, Low Temperature Cabinets and similar equipment); W. A. Smylie, Chief, Air Conditioning Unit (Central Plant Air Conditioning and Humidifiers); Florence Stanton, Control, Mail and Files; and W. A. Smylie, Chief, (Acting) Fin Coil Accessory Unit (Fin Coils, Controls, Valves, Fittings and other Accessories).

Fuel Saving Plan Popular

Nearly 4,000 engineers have volunteered for service in behalf of the Bureau of Mines fuel efficiency program and new enlistments are pouring in daily, Secretary of the Interior Harold L. Ickes has announced.

Designed to minimize wasteful practices in the use of coal, coke, wood, petroleum, and gas as a part of the Government's critical resources conservation campaign, the program is being organized by a recently appointed National Fuel Efficiency Council, with the cooperation of the Bureau of Mines.

Fuel efficiency information acquired through years of research by the Bureau of Mines will be made available in addition to the "on-the-spot" recommendations of competent regional engineers who will serve without pay.

The National Fuel Efficiency Council of 12 engineers outstanding in the field of fuel utilization has enlisted the cooperation of national engineering societies and many manufacturers of fuel-burning and control equipment through its chairman, Thomas C. Cheasley, Bureau of Mines supervising engineer.

Later, the committee plans to expand its program to include small consumers, home owners and others.

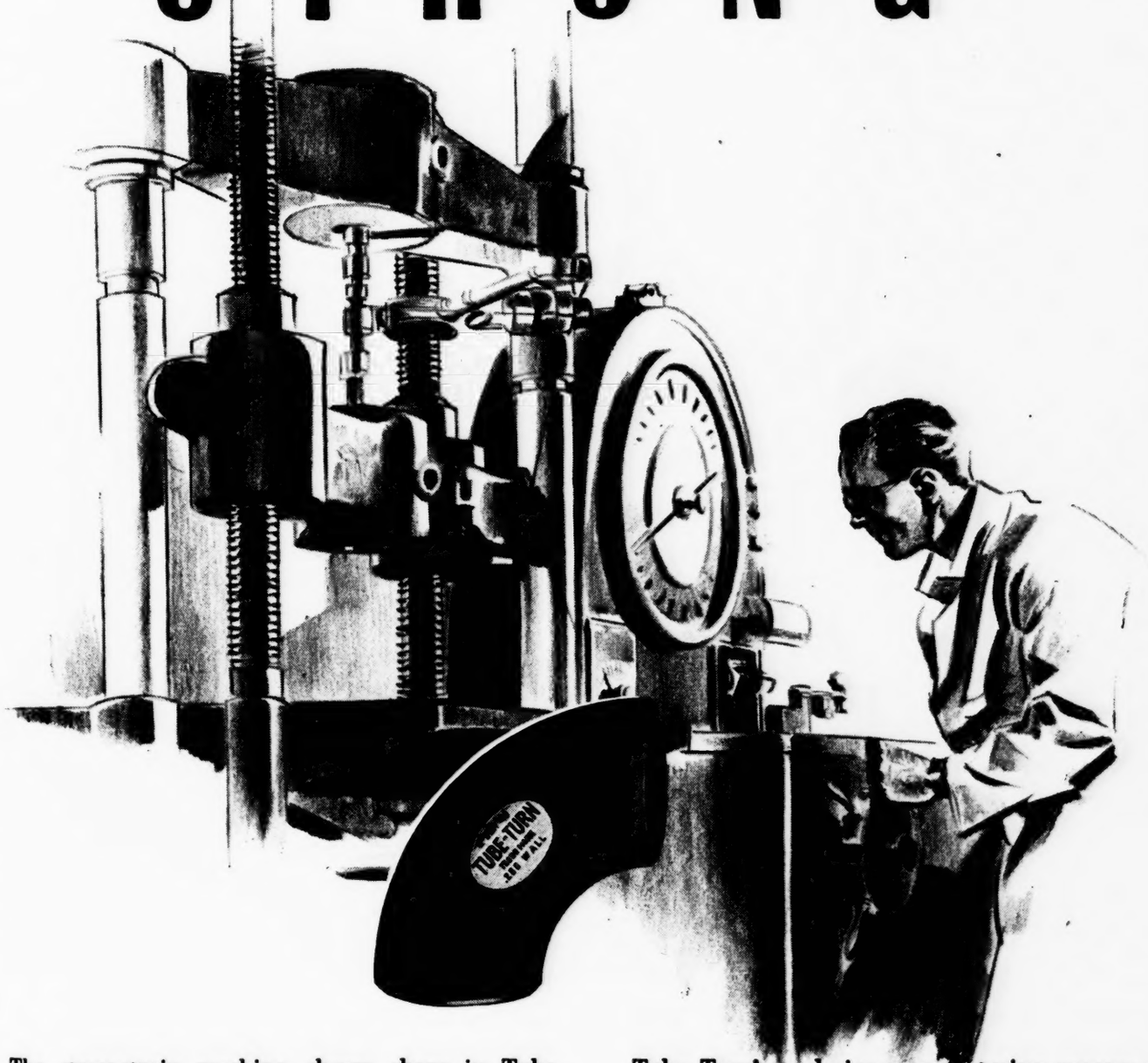
Boilers Simplified

Gas-fired low-pressure heating boilers have been brought under the simplification restrictions of Schedule III of Order L-42 by the War Production Board. Under the amendment to Schedule III, fusible plugs, tri-cocks and metal jackets (except for gas-fired burner-boiler units necessary as a functional part of the boiler) are prohibited for low-pressure heating boilers fired by solid, liquid or gas fuel.

Thermometer Demand Steady

Requirements for industrial thermometers in 1944 will equal 1943 production and may exceed it by about 25 per cent, the Industrial Thermometer Industry Advisory Committee has been told.

STRONG

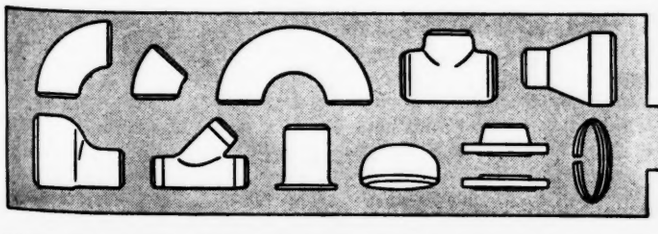


The stress-strain machine, shown above in Tube Turns' laboratories, scientifically records tensile strength.

Welding fittings *must* be strong. Stronger than pipe. For the greatest strain and vibration occur *at the fittings.* Strength is imperative against the high pressures, extreme velocities and corrosive wear to which fittings are subjected in many piping systems. Strong welding fittings help to hold leakage, breakdowns and consequent repairs to a minimum.

Tube Turn's exclusive manufacturing process produces *extra* strong fittings. Tensile tests on the stress-strain recording machine methodically *insure* the superior strength standards found in all Tube-Turn seamless welding fittings.

TUBE TURNS (Inc.) Louisville, Kentucky. *Branch Offices:* New York, Chicago, Philadelphia, Pittsburgh, Cleveland, Dayton, Washington, D. C., Houston, San Francisco, Seattle . . . Distributors located in principal cities.



TUBE-TURN

TRADE MARK

Welding Fittings and Flanges

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Heatronic molding of plastics was shown. Through electrostatic heating, lumps of plastic material are uniformly heated before being molded, and molding time is reduced from minutes to seconds.

The U. S. Army, Chemical Warfare Service, featured latest developments in smoke, flame and gas protective equipment.

Cooling System to Stop Fumes

LOS ANGELES—Revising previous plans for eliminating the issuance of noxious fumes from the Southern California Gas Co.'s Los Angeles butadiene plant, which called for a housing over the existing cooling tower, installation on an entirely new enclosed cooling system was begun in November and was expected to be completed by January 15 at a total cost of $750,000.

The new cooling system is designed to eliminate unpleasant fumes which were thrown off during the cooling process with the equipment installed last summer when the plant first went into production of butadiene for synthetic rubber.

Butadiene production was halted in mid-November to begin installation of the new cooling system. This consists of 45 heat exchangers, which are being installed by the C. F. Braun Co., the firm which designed and installed the absorption plant. Thirty heat exchangers were in place on December 18, at which time the plant returned to production of butadiene on a restricted basis. The entire 45 units were expected to be in by January 15, the scheduled date for the plant to go on full production of 35,000 tons of butadiene per year.

The heat exchangers are 36 inches in diameter and 22 feet long. Each contains 20 feet of copper coils for a total cooling surface in the 45 units of 196,000 square feet. They are set up in banks of three adjacent to the existing cooling tower and are capable of handling 16,000 gpm of oily water and 24,000 gpm of the clear water used for cooling.

Operation of the original system resulted in objectionable fumes when the vapors representing high octane gasoline values were cooled in the open-air cooling tower. In this operation a small portion of an odorous oil emulsion precipitated out with the gas became entrained in the water and was sprayed into the outside air.

By the new cooling method, the vapors go from the gas scrubbers into the copper tubes of the heat exchanger, with the cooling water, enclosed by the shell of the exchanger, leaving the outside of the tubes but permitting no water or vapors to contact the atmosphere.

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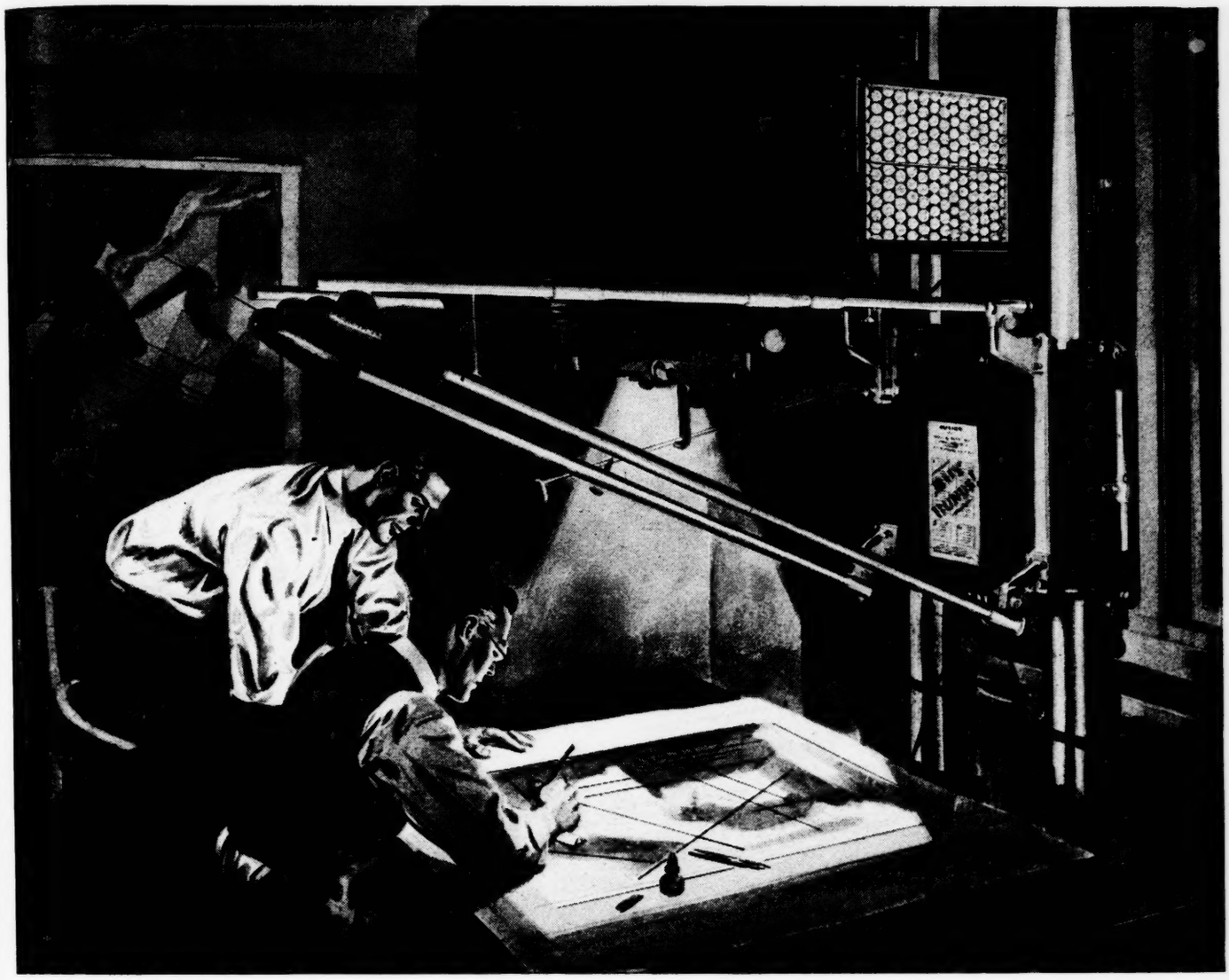

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ARMY (E) NAVY

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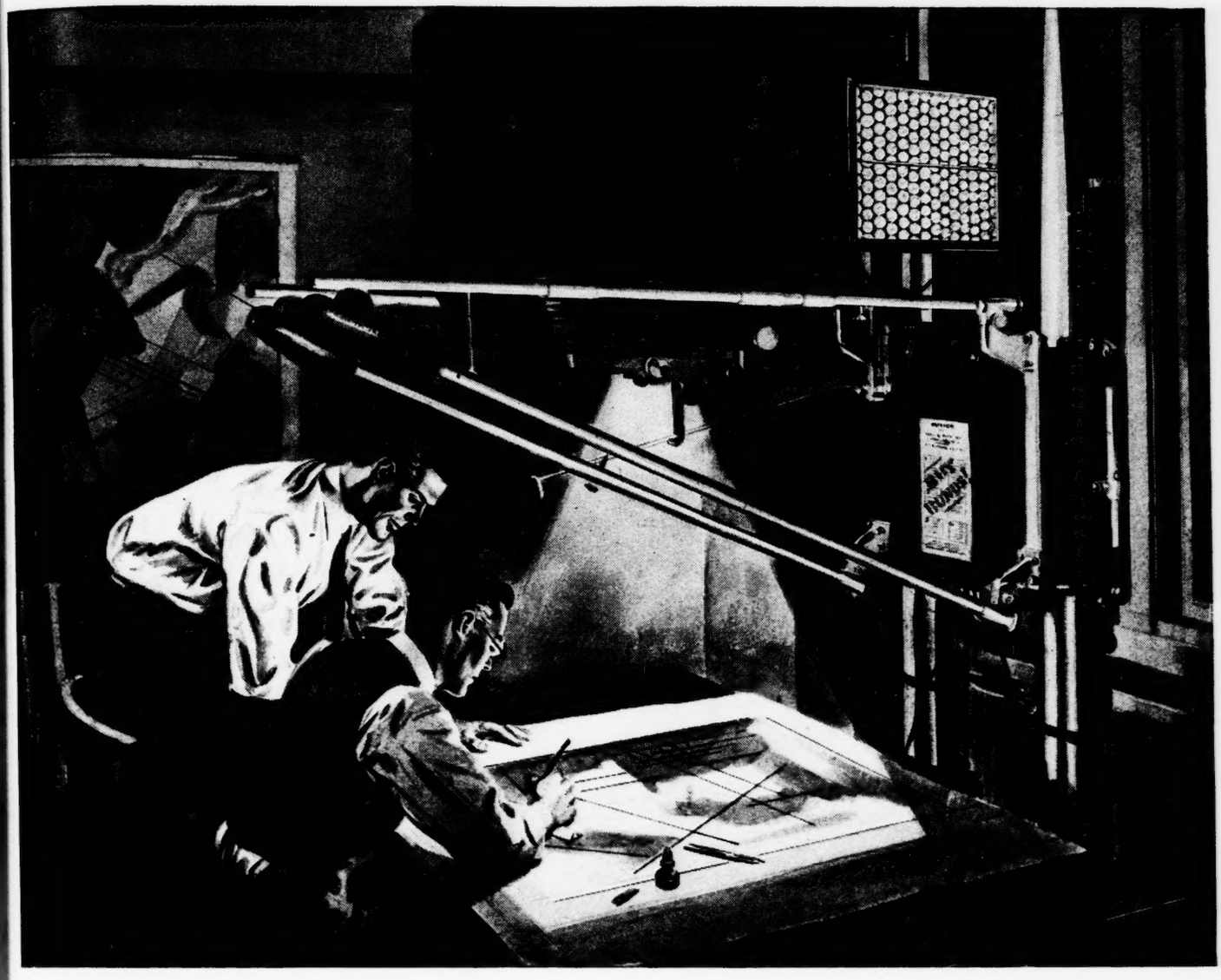

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AIR FILTERS

NEWS OF EQUIPMENT AND MATERIALS

Century Motor

NAME—Century Form J open-rated motor.
PURPOSE—General purposes.
FEATURES—Upper half of the end bracket is closed to minimize the

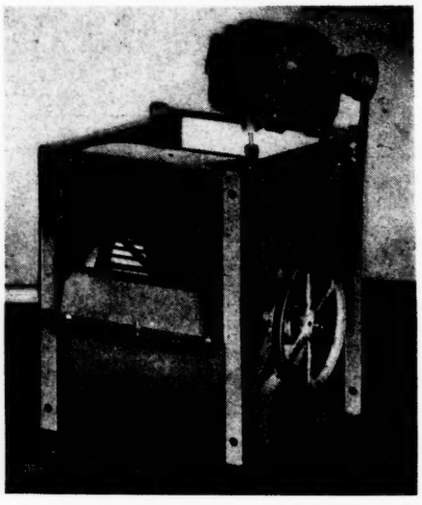
possibility of dripping liquids or falling solids entering the vital parts of the motor. Two powerful fans located behind the bearing brackets draw cooling air through the bearing bracket openings around the bearings, across the windings and to the air passages between the outer surfaces of the magnetic core and the frame, the heated air being expelled through openings at the side and bottom of the frame.
SIZES AND CAPACITIES—Available in sizes from 1½ to 15 hp.
LITERATURE AVAILABLE—Bulletin 6-1.
MANUFACTURED BY—*Century Electric Co., 1806 Pine St., St. Louis 3, Mo.*

Air Blaster

NAME—The Air Blaster.
PURPOSE — Axial-flow fan for industrial and marine applications, and for cooling condensers, transformers and heat exchangers.
FEATURES—Unit consists of a heavy gauge welded steel housing mounted on an adjustable pedestal which may be tilted 60 degrees up or down, with axial-flow fan in a relatively long cylindrical housing. Manufacturer claims that this fan delivers a large volume of air in a straight line to the spot where it is needed.
SIZES AND CAPACITIES—Three sizes: 18 in., ¾ hp, 6000 cfm; 24 in., 1½ hp, 9000 cfm; 30 in., 1½ hp, 11000 cfm.
MADE BY—*Chelsea Fan & Blower Co., Inc., 1206 Grove St., Irvington, N. J.*

Blower

NAME—"Quad" 4-way interchangeable blower.
PURPOSE—Wider application.
FEATURES — Wheel diameter sizes range from 6 to 25 in. Blower may



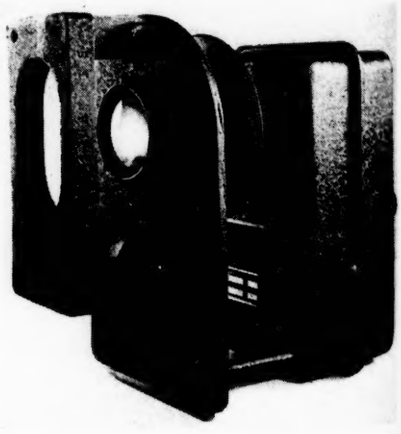
be driven from the right or left and a new type motor mount enables the driving motor to be quickly attached to the top, rear or front of the blower frame.
MADE BY — *Trade-Wind Motorfans, Inc., 5725 So. Main St., Los Angeles.*

Moduflow for Houses

NAME—Moduflow controls for house heating systems.
PURPOSE — To control heat distribution fluctuating in accordance with heat losses; for hot water, steam, or warm air systems.
FEATURES—Controls consist of a line of devices depending on the type of heating systems with which they are to be used. Common to all is a Moduflow thermostat, an extremely sensitive device for controlling the flow of the heating medium. In all cases the burner is under the control of a limit control on the boiler or furnace. In the case of steam systems a Moduflow steam valve and orifices in the radiator inlet valve are used to vary the flow of the heating medium and to equalize the distribution; in the case of a hot water system a Moduflow three-way mixing valve is under the control of the modulating thermostat and permits a variable mixture of hot water from boiler and cool water by-passed around the water to flow to the radiator; similarly in a warm air system a by-pass around the furnace is used in conjunction with the main duct from the furnace; at the junction of the two ducts, a damper operated by a Moduflow damper motor permits the mixture of air of the desired temperature to flow to the rooms.
MADE BY — *Minneapolis-Honeywell Regulator Co., 2753 Fourth Ave. South, Minneapolis, Minn.*

Electronic Safety Control

NAME—Fireye Electronic Flame Failure Safeguard.
PURPOSE—To provide instantaneous fuel cut-off should flame fail.
FEATURES—This system, which uses a photoelectric eye, is installed with the optical system focused on the burner. As long as the electric eye sees the flame, no action takes place. Should the flame fail, then by means of an electronic control, a relay is operated to actuate a solenoid valve. The fuel supply is cut off until proper conditions are restored.
MADE BY—*Combustion Control Corporation, 77 Broadway, Cambridge 42, Mass.*



CHECK LIST FOR CONSERVATION OF FUEL—3

CHECK LIST FOR HOT WATER HEATING SYSTEM

LOCATION	Building Name .... Checked by ..... Location ..... Date .....
FLOW AND RETURN MAINS AND BRANCHES	Improperly graded ..... Trapped ..... Improperly sized ..... Leaking ..... Uninsulated ..... Special service needed .....
BOILER	Improperly sized ..... Improper type ..... Leaking ..... Flues need cleaning ..... Insulation needed ..... Door and frame leaks ..... Ash pit dirty ..... Grates need replacing ..... Defective parts ..... How fired ..... Draft and check dampers bind .....
CHIMNEY	Repairs needed ..... Cleaning needed ..... Too small in diameter ..... Too short ..... Obstructed by high trees or surrounding buildings .....
PRESSURE SYSTEM	Pressure tank improperly connected ..... Pressure tank water-logged ..... Pressure relief valve improperly installed. Pressure relief valve faulty ..... Damper regulator inoperative ..... Damper regulator improperly connected or adjusted ..... Pressure gauge faulty ..... Thermometer faulty ..... Pressure reducing valve faulty .....
FIRING DEVICE	Stoker or burner needs repairs..... Proper grade fuel being used? Yes.. No.. Combustion..... Good..... Bad..... Air.... Too much..... Too little.....
CONTROL EQUIPMENT	Room thermostat faulty ..... Improperly located ..... Burner control faulty ..... Relay faulty ..... Thermostat setting..Too high.. Too low..
WATER CIRCULATING PUMP	Improperly installed ..... Improperly sized ..... Motor faulty ..... Pump leaking ..... Improperly lubricated ..... Improperly controlled ..... Noisy .....
RADIATORS	Improperly located ..... Improperly sized ..... Not needed ..... Obstructed by Dirty convectors ..... Air valve faulty ..... Radiator valve faulty ..... Circulation through radiators Good.. Bad..

CHECK LIST FOR EVENING INSPECTION

INSPECTION	Checked by ..... Date .....
WALL, FLOOR AND ROOF OPENINGS (Incl. Penthouse)	Shut down fan ..... Close louvres or opening ..... Close roof trap-door tight ..... Close floor openings ..... Note difficulties .....
RADIATORS	Open valve if under control ..... Where feasible, shut valve in unoccupied rooms ..... Note difficulties Valve ..... Air valve .....

CHECK LIST FOR OPERATING ECONOMY

Run ventilating fans only when needed and no faster than necessary.

Heat to no higher temperature than necessary.

Turn heat off wherever and whenever not needed; especially in vacant rooms.

Turn radiator valves either entirely off or entirely on.

Check air-fuel proportion.

Carry minimum boiler temperature.

Carry a protective ash bed on grates.

Promptly move out ash discharged from grate.

Carry on a regular schedule of maintenance.

Study damper control for best operation.

Study methods of heat saving, sources of building heat loss, heating and ventilating system operation and peculiarities of tenants.

Instruct and arouse enthusiasm in building employes.

Keep daily records of fuel use, degree-days, wind, rain and difficulties.

When in doubt secure advice from: Local heating contractor of ability.

Published by HEATING AND VENTILATING, *148 Lafayette St., New York.* *1/44* *Copyright, 1944, by* THE INDUSTRIAL PRESS

CHECK LIST FOR CONSERVATION OF FUEL—3

RECORDS AND DATA ON PAST OPERATIONS

Name of Building ..... Search by .....
Location of Building ..... Date .....

BUILDING

Type .....
Age .....
Height .....
Ground Floor Dimensions .....
Major Changes .....
.....
.....
Kind of Fuel Used .....
District Heating Service Used .....
Fuel or Service Records furnished by .....

HEATING SYSTEM

Type .....
Age .....
Kind of Temperature Control .....
.....
Major Changes .....
.....
.....
Degree-days in Normal Year .....

FULL RECORD

Period Included Between (Days)	Total Fuel or Service Used	Amount Fuel or Service Non-heating	Fuel or Service Space Heating	Unit	1000 Btu per Unit	1000 Btu for Space Heating	D.D. in Period	1000 Btu per D.D.	1000 Btu per Normal Year
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
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CONDITIONS DURING PERIOD

Overheating
General..... Local..... When..... Where..... Est. Temp. ..... Cause.....

Underheating
General..... Local..... When..... Where..... Est. Temp. ..... Cause.....
Percentage of building occupied ..... Percentage heated .....
Was there any other considerable source of heat? .....
Describe .....

Occupancy Hours
Weekdays..... to..... Saturdays..... to Sundays..... to..... Holidays..... to.....
Temperatures during occupancy ..... During non-occupancy .....
Odd hour occupants .....
System difficulties such as leaks .....
.....
Tenants opening windows .....
Other tenant peculiarities .....
Skill, energy and enthusiasm of operators .....

Check list compiled with the cooperation of H. A. Thrush & Co., Peru, Ind.

Published by HEATING AND VENTILATING, *148 Lafayette St., New York.* *1/44* *Copyright, 1944, by* THE INDUSTRIAL PRESS

Class in Electricity

Drawn from widely separated peacetime occupations, these purposeful learners in a Bethlehem shipyard are being taught the essentials of marine electrical work.

None of them had ever before set foot in a shipyard, or had any experience with electricity beyond changing a light bulb or plugging in a toaster. But soon these same men and women will be installing complicated electrical wiring on troopships and cargo carriers—and doing the work with speed and skill comparable to an experienced electrician.

Not that full-fledged electricians can be produced in a few short weeks. But by well-planned training, learners who are responsive and alert can quickly be trained to do some one branch of the work, and do it with speed and proficiency.

Training unskilled workers in marine electricity has been done successfully by following the same principle as in training workers for hundreds of other jobs: Take complicated operations or crafts that normally call for perfected skills, and break them up into their simple, readily-learned component parts.

Since 1939 Bethlehem employment rolls have increased from 100,000 workers to nearly 300,000, while 65,000 employees have left to join the armed forces. Four out of five of our present employees are virtually newcomers, many of them women.

With instructors and supervisory people selected from among older employees to teach and guide them, these new workers have been given intensive, streamlined courses in the things they need to know.

Their zeal, their eager responsiveness to training, their ready adaptability to new tasks and surroundings, have paved the way for the all-time records Bethlehem is establishing in steel-making and ship construction.

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REVIEWS

FUEL CONSERVATION

The Engineering Experiment Station of the University of Minnesota, Minneapolis, has recently issued a very timely and constructive 62-page pamphlet entitled "Conservation of Fuels", the authors of which are Frank B. Rowley, director, Engineering Experiment Station; Richard C. Jordan, associate professor and assistant director, Engineering Experiment Station; and Clarence E. Lunc, associate professor and assistant director, Engineering Experiment Station. The publication is the result of research sponsored by the Graduate School of the University of Minnesota in cooperation with the Engineering Experiment Station.

Included in the bulletin is information on average heating season temperatures in Minnesota, Degree Days in that State, and a tabulation of Degree Days for cities in other states together with formulas for estimating seasonal consumption of fuel. Included are able summaries on temperature control of the human body, effective temperatures, effect of cold walls on comfort and fuel requirements, methods of increasing the efficiency of the heating plant, effect of lower inside temperatures on fuel consumption, and a brief but comprehensive discussion of the relative advantages in regard to fuel saving, of weather-stripping, insulation and storm windows. Condensation of moisture within building structures is treated in the final section.

The bulletin concludes with a summary of fuel conservation methods for various types of structures and types of heating systems. Price, 40c per single copy. Thirty cents for lots of ten or more.

MARINE PIPING

Marine piping is a complex and, to a large extent, a specialized subject heretofore not adequately covered in book form. Consequently, the Marine Piping Handbook fills a real need. Written by Edward P. Goehring, the book is 5¼ x 7½ in., cloth-bound, and with 662 pages. It is intended for both designers and operators.

The handbook includes sections on piping, pipe fittings, flanges and supports; valves; main and auxiliary machinery; hull drawings; piping systems, diagrammatic drawings and system calculations; systems of drawings; tables and information, and shipyard abbreviations and glossary. It is to be highly recommended, since it is well written, covers the subject in a practical way, and is well and profusely illustrated.

Published by the Cornell Maritime Press, 241 W. 23rd St., New York 11, N. Y. The price of the book is $5.00.

BRIEF REVIEWS

Salvage in Industry—The WPB has just published a 243-page illustrated paper bound book on "Salvage Manual for Industry," price 50 cents per copy. This book, which may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., covers organizing and planning a salvage department; administrative factors; methods of handling, identifying, segregating, collecting and storing scrap; handling specific waste material; descriptions of exemplary practices. A large number of engineers contributed to this publication.

Resistance of Corn to Air Flow—In the design of a natural or mechanical ventilating system for drying high-moisture shelled corn, reliable data are desirable. With this objective, the Iowa Agricultural Experiment Station conducted tests cooperatively with the U. S. Bureau of Plant Industry, Soils, and Agricultural Engineering and the results appear in the November, 1943 issue of *Agricultural Engineering* under the title of "Resistance of Shelled Corn and Bin Walls to Air Flow," under the authorship of S. Milton Henderson.

Cooling Power—Robert G. Stone, of the Blue Hill Observatory, Harvard University, presents in the October, 1943 issue of the Bulletin of the American Meteorological Society the first of a series of two articles "On the Practical Evaluation and Interpretation of the Cooling Power in Bioclimatology." In the first installment the kata-thermometer, Frigorimeter, and effect of altitude are considered. In the November issue the author discusses computation of solar radiation effects, effect of clothing, evaporating power, sensation scales, and correlations.

Air Conditioning Design — A 4-page folder entitled Improving Installation Design and Reducing Investment Cost of Gas Air Conditioning Systems, by G. E. May, Chairman of the Technical Advisory Committee on Gas Summer Air Conditioning. The pamphlet includes suggestions for reducing operating costs in gas air conditioning systems by proper design methods such as using only maximum simultaneous loads, proper methods of handling sun effect, careful consideration of ventilation and load factors. While the article deals specifically with gas air conditioning the points are applicable to all types of air conditioning. Available from the American Gas Association, 420 Lexington Ave., New York.

Heat Correction Guide—Bulletin 56 of the National Housing Agency of the Federal Public Housing Authority. Booklet consists of 24 multilithed pages of which nine are devoted to a checklist of troubles and their solutions on forced warm air heating systems while the remaining fifteen pages are devoted to drawings illustrating the points mentioned in the checklist.

Activities of Anthracite Industries, Inc.—An attractive, readable presentation of how this group is aiding the government dealer and consumer of anthracite. It has helped men in the service in firing and maintenance methods, and it has saved much money for the government by testing heating equipment for military and civilian use. Changes are suggested to conserve critical material.

Coke Distribution—United States Bureau of Mines publication M.M.S. No. 1109 by A. F. Fritzlen and M. M. Otero, on "Distribution of Byproducts and Beehive Coke in the United States, 1942." In this seventh report by the Bureau of Mines on coke distribution, data are given by graphs and tables on the coke shipped to states and the source of the coke.

Furnace Standards—A set of 34 mimeographed sheets on Commercial Standard for "Solid Fuel Burning Furnaces, CS 109-44," issued by the U. S. Department of Commerce, Washington, D. C. Since there was no opposition to the proposed standard as circulated, the Bureau has announced that these regulations or standards will pertain to the field.

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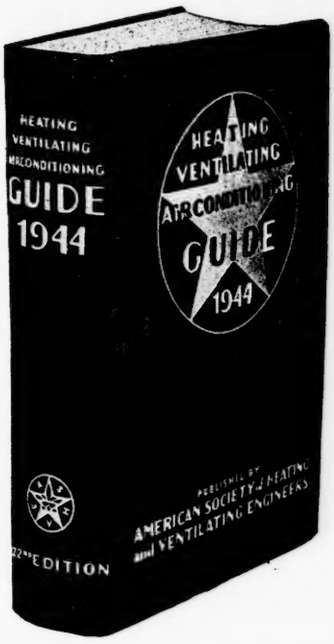
Fundamentals for the Entire Industry

In Seven chapters, are fundamental data on Air and Water; Heat Transfer and Heat Transmission with data on Insulation; Air Leakage; Heating and Cooling Loads; Combustion of Fuels and Methods of Estimating Fuel Consumption; Chimney and Draft Calculations; and Automatic Fuel Burning Equipment.

Steam and Hot Water Heating

Seven chapters treating the entire subject: Boilers, Radiators and Convectors; Steam and Hot Water Heating Systems and Piping; Data on Pipe, Fittings and Welding; District Heating; a chapter on Radiant Heating; and Water Supply Piping and Water Heating.



Air Heating, Cooling and Conditioning

Fifteen chapters covering the field of Warm Air Heating—gravity type and mechanical furnace systems; Central Systems for Comfort Air Conditioning; Unit Heaters, Ventilators, Humidifiers; Unit Air Conditioners, Air Coolers and Attic Fans; data on Cooling, Spray Equipment, Dehumidification, Dehydration; Refrigeration; Heat Transfer Surfaces; Air Pollution and Air Cleaning; Fans, Air Distribution, Air Duct Design, and Sound Control.

Automatic Controls, Instruments, Motors

Information relating to Automatic Controls for heating, and cooling equipment; Instruments and Test Methods; Motors for use with heating, cooling and ventilating equipment; and Motor Controls.

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Degree-Days for November, 1943

HEATING AND VENTILATING'S 16th year of publication of monthly degree-day data

City	Monthly Degree-Days			Cumulative Degree-Days[1]			Year[2]
	Degree-Days, Nov., 1943	Degree-Days, Nov., 1942	Degree-Days, Nov., Normal	Season, 9/1/43-11/30/43	Season, 9/1/42-11/30/42	Season, Normal, 9/1-11/30	Normal, 9/1-6/30
Abilene, Texas	302	240	333	380	365	333	2061
Albany, New York	871	799	774	1527	1391	1292	6580
Albuquerque, New Mexico	624	504	630	888	748	903	4298
Alpena, Michigan	909	857	912	1785	1655	1704	8299*
Anaconda, Montana	929	1061	951	1710	1935	1933	8357**
Asheville, North Carolina	609	514	576	1039	836	852	4232
Atlanta, Georgia	411	335	396	604	453	492	2890
Atlantic City, New Jersey	562	454	588	900	690	842	5176
Augusta, Georgia	335	233	321	440	292	337	2161
Baker, Oregon	792	869	849	1424	1547	1659	7163
Baltimore, Maryland	536	484	567	863	683	790	4533
Billings, Montana	760	892	909	1313	1576	1622	7119
Binghamton, New York	841	752	798	1525	1280	1359	6808
Birmingham, Alabama	487	269	318	680	374	318	2352
Bismarck, North Dakota	1038	1055	1113	1690	1961	1961	9192
Block Island, Rhode Island	592	579	573	985	948	852	5788
Boise, Idaho	750	759	738	1158	1266	1274	5552
Boston, Massachusetts	648	646	693	1123	1037	1104	6045
Bozeman, Montana	902	1019	1006	1696	1902	1993	8521**
Buffalo, New York	827	739	774	1530	1260	1268	6822
Burlington, Vermont	900	863	861	1659	1574	1486	7514
Butte, Montana	977	1110	923	1889	2148	1922	8272
Cairo, Illinois	569	411	519	811	628	677	3909
Canton, New York	921	876	906	1743	1567	1652	8020
Charles City, Iowa	1014	895	936	1761	1599	1505	7588
Charleston, South Carolina	272	154	207	338	183	207	1769
Charlotte, North Carolina	416	359	426	618	487	541	3120
Chattanooga, Tennessee	560	407	426	799	625	531	3118
Cheyenne, Wyoming	847	871	900	1625	1745	1745	7466
Chicago, Illinois	863	723	450	1393	1285	800	5957
Cincinnati, Ohio	679	548	615	1056	938	869	4684
Cleveland, Ohio	737	635	732	1272	1066	1125	6155
Columbia, Missouri	702	531	651	1068	914	911	4922
Columbia, South Carolina	358	258	324	472	317	355	2364
Columbus, Ohio	684	607	690	1134	986	1003	5398
Concord, New Hampshire	849	851	846	1578	1508	1498	7353
Concordia, Kansas	732	648	693	1128	1059	969	5315
Dallas, Texas	317	219	303	401	333	303	2256
Davenport, Iowa	857	726	795	1336	1225	1158	6289
Dayton, Ohio	782	586	660	1262	994	933	5264
Denver, Colorado	680	657	759	1117	1233	1259	5874
Des Moines, Iowa	880	738	798	1414	1249	1155	6384
Detroit, Michigan	804	717	777	1422	1270	1219	6490
Devils Lake, North Dakota	1147	1159	1179	1984	2093	2161	9970
Dodge City, Kansas	675	610	672	1027	977	948	5035
Dubuque, Iowa	919	780	846	1519	1379	1291	6790
Duluth, Minnesota	1179	1084	1074	2118	2021	1970	9443
Eastport, Maine	806	839	843	1565	1579	1662	8520**
Elkins, West Virginia	770	643	741	1459	1111	1182	5697
El Paso, Texas	(a)	216	381	(a)	292	421	2428
Ely, Nevada	866	915	—	1600	1801	—	—
Erie, Pennsylvania	757	665	761	1326	1100	1125	6273
Escanaba, Michigan	979	938	960	1871	1787	1794	8771*
Evansville, Indiana	668	509	528	1036	881	683	4244
Fort Smith, Arkansas	442	340	408	592	499	470	3147
Fort Wayne, Indiana	856	700	726	1495	1257	1073	5925
Fort Worth, Texas	297	209	252	373	312	252	2148
Fresno, California	329	374	315	435	448	334	2334
Galveston, Texas	156	77	60	184	84	60	1016
Grand Junction, Colorado	710	679	747	981	1026	1116	5548
Grand Rapids, Michigan	825	720	774	1451	1297	1250	6535
Green Bay, Wisconsin	994	898	921	1768	1585	1558	7825
Greensboro, North Carolina	554	476	492	879	699	635	3529
Greenville, South Carolina	445	363	450	657	499	596	3380
Harrisburg, Pennsylvania	700	637	660	1165	979	989	5375
Hartford, Connecticut	752	703	705	1286	1147	1097	6036
Hatteras, North Carolina	331	199	234	423	228	234	2571
Havre, Montana	865	1090	1041	1565	1864	1931	8700
Helena, Montana	964	1026	948	1738	1872	1813	7898
Houston, Texas	195	121	114	236	146	114	1157
Huron, South Dakota	983	944	1005	1653	1739	1654	8004
Indianapolis, Indiana	745	582	687	1163	981	985	5298
Kansas City, Missouri	698	553	639	1041	907	858	4956
Kewanee, Illinois	910	772	781	1464	1337	1193	6139
Knoxville, Tennessee	546	415	519	850	660	702	3670
La Crosse, Wisconsin	1026	861	909	1787	1530	1467	7322
Lander, Wyoming	927	1064	726	1654	1921	1656	7947

[1]Cumulative data identical with monthly figures for September only. In subsequent months, cumulative figures will show record for whole heating season to and including month in question.

[2]Figures in this column are normal totals for a complete heating season, September to June, incl.

Figures in this table, with eight exceptions, based on local weather bureau reports. Exceptions are Utica, Lewiston, Kewanee, and Sioux City, figures for which are furnished through the courtesy of Coke Sales Department, Central New York Power Corp., Utica, N. Y.; Norman E. Ross, Bursar, Bates College, Lewiston, Me.; J. M. Hartman, Engineering Department, Kewanee Boiler Corp., Kewanee, Ill., and Alfred R. Wagstaff, Engineer, Sioux City Foundry and Boiler Co., Sioux City, Iowa, respectively; Anaconda, Bozeman, Butte and Livingston, Mont., through the courtesy of the Montana Power Company.

[Table Concluded on page 92]

Our new Bulletin No. 432 describes our line of Standard Steel Plate Industrial and Heat Fans together with capacity tables and engineering data.

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Degree-Days for November, 1943 (Concluded)

HEATING AND VENTILATING'S 16th year of publication of monthly degree-day data

City	Monthly Degree-Days			Cumulative Degree-Days[1]			Year[2]
	Degree-Days, Nov., 1943	Degree-Days, Nov., 1942	Degree-Days, Nov., Normal	Season, 9/1/43-11/30/43	Season, 9/1/42-11/30/42	Season, Normal, 9/1-11/30	Normal, 9/1-6/30
Lansing, Michigan	896	784	861	1662	1466	1456	7048
Lewiston, Maine	889	898	876	1660	1600	1542	7707
Lincoln, Nebraska	819	688	753	1267	1166	1069	5999
Little Rock, Arkansas	457	343	381	600	505	428	2811
Livingston, Montana	751	899	864	1399	1770	1614	7205
Los Angeles, California	52	106	123	101	145	123	1504
Louisville, Kentucky	618	483	552	913	798	738	4180
Lynchburg, Virginia	508	458	537	815	674	757	3980
Macon, Georgia	385	250	324	519	329	330	2201
Madison, Wisconsin	972	845	891	1657	1490	1437	7429
Marquette, Michigan	989	957	960	1868	1793	1752	8693*
Memphis, Tennessee	495	311	402	688	471	464	2950
Meridian, Mississippi	418	236	312	540	338	334	2160
Milwaukee, Wisconsin	930	780	846	1621	1474	1380	7245
Minneapolis, Minnesota	1066	944	963	1782	1683	1537	7850
Modena, Utah	810	798	831	1311	1418	1504	6562
Montgomery, Alabama	338	217	273	447	267	273	1884
Nantucket, Massachusetts	578	584	609	983	959	1007	5957
Nashville, Tennessee	548	387	483	797	600	619	3507
New Haven, Connecticut	712	625	693	1209	1001	1092	5895
New Orleans, Louisiana	199	101	102	259	123	102	1024
New York, New York	607	555	618	989	810	894	5347
*Nome, Alaska	1023	1131	1509	1804	1706	3379	14580**
Norfolk, Virginia	402	307	411	599	396	510	3350
North Head, Washington	408	530	510	944	1078	1131	5452**
North Platte, Nebraska	783	779	837	1303	1375	1313	6366
Oakland, California	297	357	330	534	608	603	3143**
Oklahoma City, Oklahoma	441	397	459	587	605	564	3613
Omaha, Nebraska	877	727	780	1366	1221	1109	6131
Oswego, New York	798	752	783	1491	1274	1356	7088
Parkersburg, West Virginia	682	547	624	1116	887	909	4775
Peoria, Illinois	860	707	789	1365	1214	1173	6109
Philadelphia, Pennsylvania	574	515	588	902	760	830	4855
Phoenix, Arizona	110	77	156	134	95	156	1405
Pittsburgh, Pennsylvania	697	601	669	1503	949	982	5235
Pocatello, Idaho	824	848	813	1363	1468	1468	6655
Portland, Maine	828	863	807	1560	1559	1446	7218
Portland, Oregon	493	558	558	802	843	995	4469
Providence, Rhode Island	639	640	693	1100	1016	1104	6015
Pueblo, Colorado	765	662	741	1283	1175	1135	5514
Raleigh, North Carolina	465	360	429	682	508	559	3234
Rapid City, South Dakota	873	866	870	1459	1632	1529	7118
Reading, Pennsylvania	650	598	669	1088	925	1013	5389
Redding, California	236	356	330	400	439	349	2451
Reno, Nevada	740	692	714	1254	1251	1311	5892
Richmond, Virginia	493	428	456	768	612	617	3695
Rochester, New York	835	767	786	1535	1315	1289	6732
Roseburg, Oregon	494	503	561	806	813	1022	4428
Roswell, New Mexico	529	365	516	717	581	702	3484
Sacramento, California	299	349	351	409	422	422	2653
St. Joseph, Missouri	756	599	633	1133	1004	881	5161
St. Louis, Missouri	637	492	597	912	805	802	4585
Salt Lake City, Utah	749	733	723	1109	1225	1129	5555
San Antonio, Texas	(a)	163	126	(a)	192	126	1202
San Diego, California	111	127	165	143	153	199	1645
Sandusky, Ohio	754	658	726	1250	1099	1079	6208
San Francisco, California	172	271	261	404	560	521	3264**
Sault Ste. Marie, Michigan	1012	1006	978	2008	1930	1877	9285**
Savannah, Georgia	214	135	201	283	157	201	1490
Scranton, Pennsylvania	779	705	732	1388	1171	1189	6129
Seattle, Washington	497	581	570	908	992	1150	4934**
Sheridan, Wyoming	843	959	978	1560	1714	1878	8008
Shreveport, Louisiana	367	204	270	458	285	270	1938
Sioux City, Iowa	963	864	870	1551	1485	1318	6898
Spokane, Washington	825	895	819	1386	1472	1526	6355
Springfield, Illinois	737	598	681	1095	1007	963	5373
Springfield, Missouri	641	512	564	1022	875	781	4428
Syracuse, New York	831	752	798	1546	1318	1319	6893
Tacoma, Washington	556	620	588	1043	1090	1195	5181**
Terre Haute, Indiana	727	565	615	1104	950	848	4872
Toledo, Ohio	818	683	732	1449	1195	1110	6077
Topeka, Kansas	691	572	639	1019	911	875	4969
Trenton, New Jersey	633	573	588	1071	881	830	4933
Utica, New York	895	821	781	1632	1418	1393	6796
Valentine, Nebraska	904	863	897	1499	1606	1480	7039
Walla Walla, Washington	724	716	651	1088	991	1013	4808
Washington, Dist. Columbia	551	504	594	893	716	845	4626
Wichita, Kansas	627	548	636	882	871	828	4673
Williston, North Dakota	1001	1101	1137	1743	2014	2067	9323
Winnemucca, Nevada	755	753	810	1220	1324	1509	6427**
Yakima, Washington	759	844	780	1190	1215	1337	5599

*Includes August. **Includes July and August. (a) Data not yet available.

[1]Cumulative data identical with monthly figures for September only. In subsequent months, cumulative figures will show record for whole heating season to and including month in question.

[2]Figures in this column are normal totals for a complete heating season, September to June, incl.

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In hot weather, reducing the head pressure from 195 lbs. to 165 lbs. adds 10% to 15% extra capacity to your refrigeration system.

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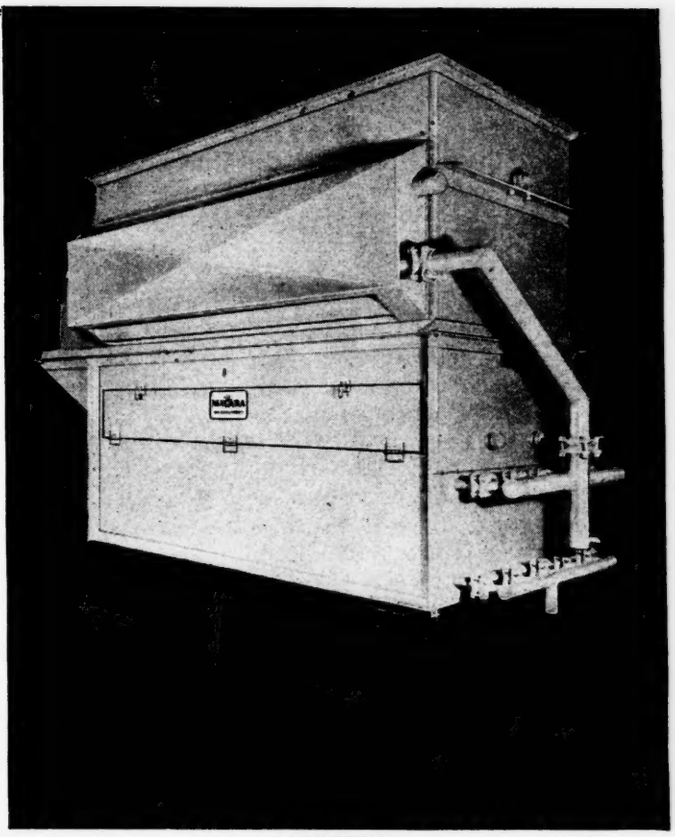

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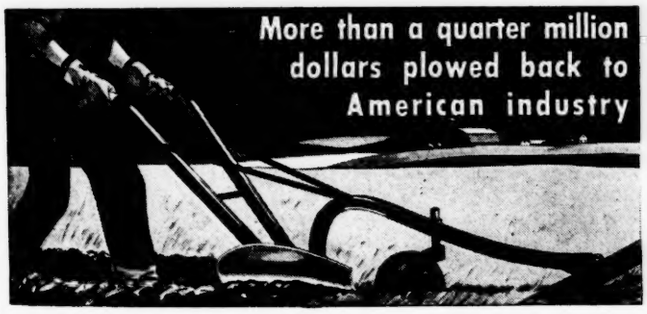

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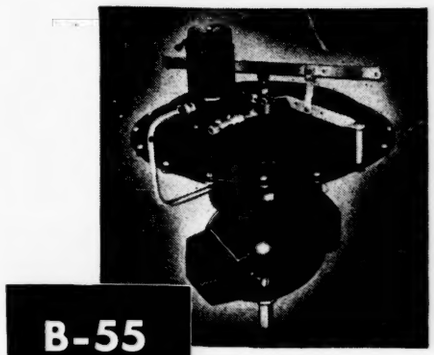


FOR INDUSTRIAL AND COMMERCIAL BURNERS AND FURNACES

Opening time adjustable, 5 to 60 seconds. • Widest range in pressures. Handles up to 5 lbs. • Widest range of sizes. Available from ¾" to 6" I.P.S. for manufactured, natural or l.p.g. gases. • Ample power is available for louvre control. Damper arm easily rotated to any desired position. • Low current consumption. In sizes up to 1½" I.P.S., uses but 8 watts.

Write for Catalog 52

GENERAL CONTROLS

801 ALLEN AVENUE • GLENDALE 1, CALIF.

BRANCHES: Boston, New York, Philadelphia, Cleveland, Detroit, Denver, Chicago, Dallas and San Francisco

FEED WATER REGULATOR

Northern Equipment Co., Erie, Pa.

The performance record of Copes Flowmatic, the steam-flow water-level feed water regulator, is summarized in a 4-page folder, Form 435, which reviews the use of this device throughout many industries on various types and sizes of boilers, and the results obtained by users since its introduction.

MODERN PLANT DESIGN

Ford, Bacon & Davis, 39 Broadway, New York.

In a 12-page illustrated booklet this company presents some new ideas in industrial plant design. Both exterior and interior views of plants are shown.

STEAM PLANT EQUIPMENT

Yarnall-Waring Co., Chestnut Hill, Philadelphia 13, Pa.

Three new bulletins have been issued by this company. Bulletin G-1306 describes the company's line of steam plant equipment such as blow-off valves for boilers, water level gages, steam traps, nozzles, etcetera. The Gun-Pakt and Gland-Pakt types of expansion joint are featured in Bulletin E-1909. The company's line of steam traps describing the methods of operation is shown in Bulletin T-1738.

INSTALLATIONS

Baker, Smith and Company, Inc., 40 West 40th St., New York 18, N. Y.

Under the title of "Installations" this company has listed pictorially its designs in the heating, ventilation, power equipment, industrial piping, and air conditioning fields. The work includes such outstanding projects as the Parkchester development, the Pennsylvania Hotel, Rockefeller Center, Empire State Building and the Chrysler Building. Also included is an interesting company history on its development and growth.

BUTTERFLY VALVES

R-S Products Corp., Wayne Junction, Philadelphia 44, Pa.

A complete line of butterfly valves is illustrated in this 36-page booklet which contains detailed specifications, applications and descriptions of many valves. This catalog, No. 14-B, has information on valves for pressures as high as 900 lb per sq in.

ELECTRIC DRIVE

General Electric Co., Schenectady, N. Y.

Features and applications of Thy-mo-trol, electric drive developed by the General Electric Company, are described in a 36-page booklet. The first part presents detailed functions and advantages of this form of drive while the latter half of the booklet includes applications such as grinders, machine tools, and machines for testing.

HUMIDIFIERS

Armstrong Machine Works, Three Rivers, Mich.

An 8-page bulletin No. 158, presenting engineering data and complete details on unit steam type humidifiers available for industrial plants where humidification is necessary, due to the industrial process being carried on. Also included are operating features, installation data and other information on these units.

PERSONALS AND PERSONNEL

Richard S. Dawson

RICHARD S. DAWSON

for the last four years general sales manager of the Alco Valve Co., St. Louis, has been elected vice-president in charge of sales. Mr. Dawson studied engineering at Syracuse University and the Massachusetts Institute of Technology, later becoming a telephone engineer for the Bell System and taking that company's engineering course. In 1926 he joined the American Radiator Co., serving as field engineer and with the general sales office in New York, later being transferred to the Detroit Lubricator Division as the Philadelphia representative. He moved in 1935 to the Fulton Sylphon Co. as manager of the refrigeration division. Joining Alco in 1938 as assistant New York manager, he was called to the home office in St. Louis the following year to take up the duties of general sales manager.

EARL J. GOSSETT

has been elected a director of the United States Radiator Corporation, Detroit. Mr. Gossett is president of Bell & Gossett, Chicago.

DONALD J. LUTY

has been promoted by the Gar Wood Industries, Inc., Detroit, Mich., to the position of general manager of the heating division. He had been with the company for 14 years and for many years was assistant general manager of this division. He also held the title of chief research engineer for the company.

R. D. ULREY

has been appointed manager of the new Los Angeles, California, office of the Joshua Hendy Iron Works, Crocker-Wheeler Electric Division. This office will serve the area of Southern California, Arizona, and New Mexico and is located in the Pacific Mutual Building, 523 West Sixth St., Los Angeles.

WILLIAM L. McGRATH

executive vice president of the Williamson Heater Company, Cincinnati, has been elected president to succeed the late W. C. Williamson. Mr. McGrath, connected with the company since 1920, has served as vice-president for the last 10 years. He is a past president of the National Warm Air Heating and Air Conditioning Association.

PETER STORTI

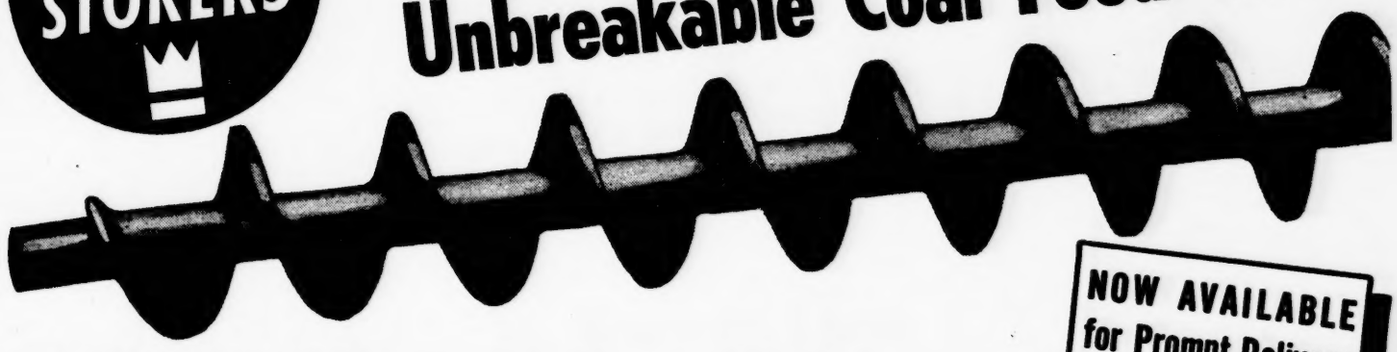
has been appointed manager of the Combustion Equipment Division of Enterprise Engine & Foundry Co., 18th and Florida Sts., San Francisco, Calif. He has had 20 years experience in the oil and gas burner field, and before coming with this company, was for 16 years with the Ray Burner Company.

JOHN G. BERGDOLL

general works manager of the York Corporation, was presented the Wolverine award for the year's most outstanding technical paper on refrigeration, at the 39th Annual Meeting of the American Society of Refrigerating Engineers held at Philadelphia. He was given this award for his studies of engineering problems involved in creating high altitude weather inside the new stratosphere test chamber developed in the York research laboratories.

For STOKERS

The CROWN Unbreakable Coal Feed Screw



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WELDED All-Steel Worm—All Sizes—All Pitches

★ For replacement or production needs, Crown is now able to offer for prompt delivery its unbreakable, all-steel Coal Feed Screw. Available with right or left hand screw, in all sizes and pitches, tapered or straight, and in combinations of pitches. For both domestic and industrial stokers, the Crown Coal Feed Screw insures longer and continuous operation because it is all-steel and because it is machined so smoothly that wear is reduced to a minimum. This smooth surface is your assurance, too, that coal will flow freely and easily through the flights. Prompt delivery is possible because production requires less time on Crown's automatic machines and because the steel used in Crown's Coal Feed Screw, while critical, does not have to contend with the enormous priorities required by the makers of other screws.

In ordering give complete specifications on size and design.

CROWN IRON WORKS COMPANY

1229 Tyler St., N. E. *Since 1878* Minneapolis, Minn.

Your Search is Ended

HERE is a FLOW METER that CANNOT BE DAMAGED

by sudden overload or Reverse Flows

You can depend on ADSCO Flow Meters to maintain their accuracy under the most severe operating conditions.

Whether you measure steam, water, compressed air, high pressure gas flows or fluids, its exclusive simplified "free floating" meter mechanism gives it sustained operating accuracy over an exceptionally wide range of flow. Write for bulletin 35-83HV.

AMERICAN DISTRICT STEAM COMPANY NORTH TONAWANDA, N. Y.

Making "UP-TO-DATE" Steam Line Equipment for over 60 years

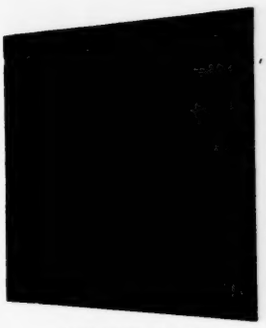
Elgo Ventilating Specialties

An Automatic Shutter with Many Advantages

Its patented spring counterbalance makes it unusually sensitive to air currents, causing the louvres to open instantly when the fan is turned on and snap tight shut when the fan is turned off.

The spring mechanism can be easily adjusted according to the air velocity, thus making the shutter adaptable to a wide range of uses.

Completely weather-stripped around the inner edge of the frame so that it is draft-proof, insect-proof, and rattle-proof.



"ELGO" TYPE AUTOMATIC SHUTTER Rear View (Closed)

Made in sizes from 10" to 60" square—also rectangular.

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Automatic Shutters · Ceiling Dampers
Balanced Vent Units · Motorized Shutters
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Free Catalog

ELGO SHUTTER & MFG. CO.

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● These dry expansion water coolers are designed especially to meet the increasing demand for cooled recirculated water in air conditioning systems of the indirect type. Shell and tube construction. They require but a small refrigerant charge. Thermostatic expansion valves simplify refrigerant control. Non-freeze. They are today supplying excellent service in hundreds of installations. A full range of capacities. Write for complete information and price list.

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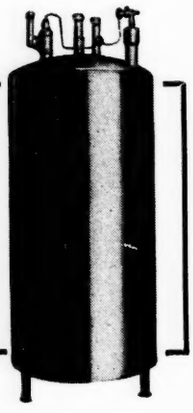
HI-PEAK WATER COOLERS

Where instantaneous high-peak delivery of cooled water is desired, Acme remote type water coolers assure ample reserve volume on demand at all times. Shell and coil construction, coils are properly sized to insure against excessive refrigerant pressure drop. Storage capacities: 12 to 168 Gal.—Write for Catalog No. 25.



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Evaporative Condensers
Forced Convection Units
Ammonia Condensers
Freon Condensers
Heat Exchangers
Pipe Coils

ACME PRODUCTS

Flooded Water Coolers
Hi-Peak Water Coolers
Dry-Ex Water Coolers
Heat Interchangers
Oil Separators
Liquid Receivers

News of the Month

(Concluded from page 84)

Louisiana Engineers to Meet

NEW ORLEANS, LA.—The program has been completed for the ninth annual meeting of the Louisiana Engineering Society to be held at the St. Charles Hotel, New Orleans, January 13-15. Each of the national engineering societies will be represented.

Two papers of particular interest to this field will be presented. They are:

"Marine Piping Systems and Their Design," by O. W. Page, Chief of Engineering Plant Approval Section, Gulf Region, U. S. Maritime Commission.

"Fundamentals of Pressure Cabin Operation," by Dr. John E. Younger, Head of Mechanical Engineering Department, University of Maryland.

In conjunction with the meeting, there will be War Production Conferences in cooperation with the War Production Board.

Harold K. Ferguson

CLEVELAND — H. K. Ferguson, president of the H. K. Ferguson Company, died at a local hospital as a result of a heart attack in his office. He was 60 years old. Mr. Ferguson was born in Albion, Mich., and graduated in 1905 from Ohio Wesleyan University. For a time he was with the Austin Company and left in 1918 to form his own organization. His company has built factories and industrial buildings in many parts of the United States and foreign countries.

George G. Gebhart

CLEVELAND—George Grove Gebhart passed away recently after an illness of more than a year. He was associated with The Hotstream Heater Company as sales manager since coming to Cleveland, twenty-one years ago.

Mr. Gebhart was a native of Dayton, Ohio, where he was born in 1886. He had been sales manager for manufacturing concerns there and at Mansfield before his arrival in Cleveland.

W. C. Williamson

CINCINNATI—Funeral services for W. C. Williamson, 84, president and co-founder of the Williamson Heater Company, warm air heater manufacturers, were held here November 29. Mr. Williamson died in Christ Hospital, November 26, after a three-day illness.

A former schoolteacher, born in Russellville, Ohio, Mr. Williamson in association with his brother, A. W. Williamson, founded the furnace company 50 years ago.

WITH THE MANUFACTURERS

LINK-BELT COMPANY

Chicago, Ill., announces that its board of directors has elected two vice-presidents, effective January 1, 1944: E. L. Berry, vice-president and general manager of Link-Belt Ordnance Company, has been elected vice-president of Link-Belt Company, the parent organization.

Richard F. Bergmann, company chief engineer, has been elected a vice-president of Link-Belt Company, with headquarters at the company's general office, Chicago, as heretofore.

John E. Martin has been appointed manager of Link-Belt Ordnance Co., with headquarters at the plant.

SHAW-PERKINS MFG. CO.

Pittsburgh, Pa., manufacturers of steam and hot water radiators has been acquired by the Jay Levine Associates of New York City, according to an announcement made December 29. Continuing in their present posts will be H. W. Rinearson, president, and J. M. Lambing, treasurer. Jay Lewine, vice president, and A. T. Thomson, secretary, are the new officers.

LINK-BELT CO.

Chicago, has promoted the following: Edward J. Burnell, heretofore vice-president and general manager in charge of Pershing Road plant operations and central division sales, has been transferred to the executive office of the company in Chicago. In his new position Mr. Burnell will be vice-president in charge of sales for the entire Link-Belt Company. Directly assisting Mr. Burnell will be Nelson L. Davis, sales manager for materials handling machinery; William H. Kinkead, sales manager for power transmission machinery; and C. Walter Spalding, sales manager for power transmission equipment required by original equipment manufacturers and duplicate machinery accounts. Harold L. Hoefman, manager of the company's Atlanta plant succeeds Mr. Burnell as general manager of the Pershing Road plant. Richard B. Holmes, district manager at Indianapolis, has been appointed manager of the Atlanta plant to succeed Mr. Hoefman. David E. Davidson, district engineer at the company's Detroit office, has been named district manager at Indianapolis, to succeed Mr. Holmes.

YORK CORPORATION

has opened new offices at 1616 Walnut St., Philadelphia. The old offices were at 1238 North 44th St. and will be used by the accounting department and for the company's regional construction department. The new offices will contain engineering, sales, maintenance and service departments.

TEMPIL CORPORATION

are distributing free pads of TEMPIL scale forms to assist in standardizing and simplifying weld bend tests. The company's address is 132 West 22nd St., New York 11, N. Y.

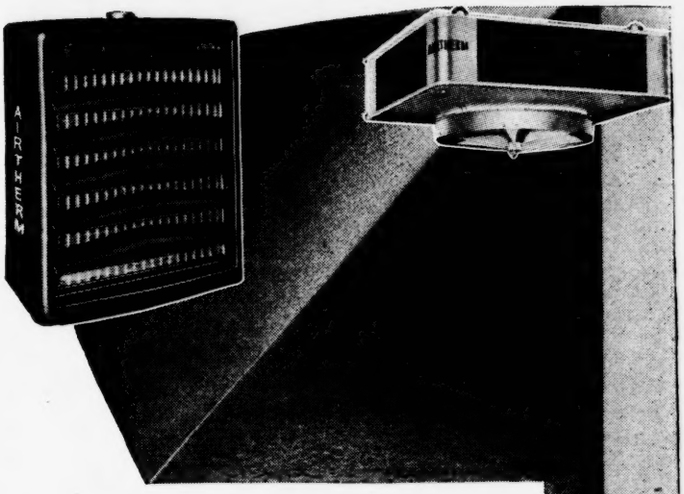
ENTERPRISE ENGINE & FOUNDRY CO.

San Francisco, Calif., has appointed E. H. Davis as manager of its Eastern district office opened at 44 Wall St., New York City. Mr. Davis will be assisted by an engineering staff composed of Robert Stickel, George Johnson, and Harry Huxford.

MINNEAPOLIS-HONEYWELL REGULATOR CO.

has announced the winners of its $10,000 heating design contest based on plans for a six-story apartment building.

First place for steam heating was awarded to Clyde M. Baker, architect, Detroit, and first prize for hot water heating to Leonard Weger, architect, Philadelphia, Pa. Second prize for steam went to Paul E. Nystrom, Madison, Wis., and for hot water heating to Walter T. Rolfe, Austin, Tex. Third prize for steam went to Abraham Walton, Jersey City, N. J., and for hot water to John A. MacWilliam and Abraham D. Rubin, Perth Amboy, N. J. More than 2,000 architects and heating engineers entered this contest and of this number 513 submitted plans in the competition.



LOW-COST HEAT SPREADS EVENLY TO ALL CORNERS *with*

AIRTHERM UNIT HEATERS

...an easy, economical way to warm every foot of floor space where steam is available. These unit heaters roll out broad streams of heated air that covers a large area and reaches even odd corners.

Airtherm insures maximum heat and usage at small cost. Both vertical and horizontal types have an extra-heavy tube-wall thickness of .065"; ingot iron tubes; and corrosion-resistant lead-alloy coated condensers.

Condensers guaranteed to withstand steam pressure up to 150 lbs. per square inch.

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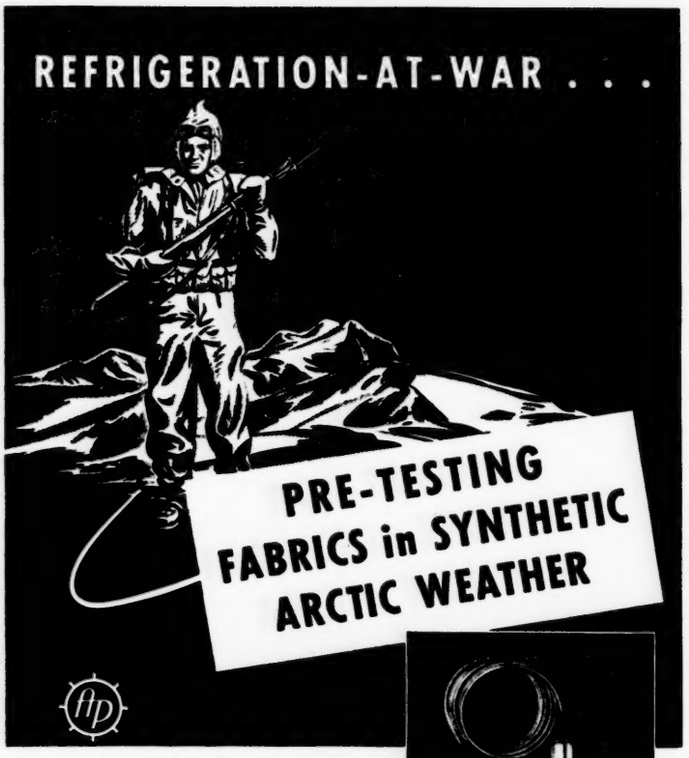

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REFRIGERANT VALVES

Thermostatic Expansion—Solenoid—Constant Suction Pressure — Water Regulating—"Trap-Dri" System Protectors — Water Solenoids — Cooling Thermostats.

Model 205 Thermostatic Expansion Valve

• "Synthetic Arctic Weather," refrigerated test chambers for pre-testing combat clothing, fabrics, guns and equipment, is but one of many precision-control applications of A-P Dependable Refrigerant Valves . . . saving time, money, and lives today.

A-P DEPENDABLE Refrigerant Valves are a highly vital part of many of today's refrigeration and air conditioning systems. Their long-established reputation for accurate and dependable refrigerant control, and for smooth, "service-free" operation, is an efficiency that you will want to add to YOUR systems — both on new installations and for replacement purposes. A-P valves are available in all capacities, for Freon, methyl chloride, and sulphur dioxide.

Remember, too, when you want effective system protection, the A-P "Trap-It" and "Trap-Dri." Placed ahead of every expansion valve, they effectively trap all system impurities and moisture — permitting smoother valve operation and preventing freeze-ups. . . . *Write for details.*

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AUTOMATIC PRODUCTS COMPANY
2462 North Thirty-Second St. Milwaukee 10, Wisconsin
Export Dept. . . . 15 East 40th Street, New York 16, New York
Stocked and sold by progressive refrigeration jobbers everywhere, used and recommended by leading service engineers.

Getting Personal

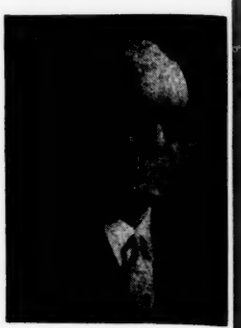
The article on "Shrink Fits," page 45 was prepared by two men well versed in this field.

Fred W. Whitcomb is a member of the Sales Engineering Staff, Deepfreeze Division, Motor Products Corporation. Since this company introduced the sub-zero machines, he has contacted over 200 firms who use or plan to use sub-zero equipment.

Alfred C. Houser, Sales Promotion Manager, Deepfreeze Division, is a former Chicago newspaperman, well known in the advertising field.

T. F. J. Moffett (Non-metallic Piping, page 51) started out as a newspaperman but since steamfitters at that time were earning the fabulous pay of $5.50 a day, he left college to become a heating apprentice. He continued his engineering studies at night.

He was a heating contractor at 25, and continued at it for 14 years. After many years as a freelance writer, he joined the staff of "Plumbing and Heating Journal," as technical editor, advancing to editor.



T. F. J. Moffett

Dr. J. M. DallaValle, author of the series of articles on "How to Design Exhaust Hoods" (Part 11, page 61), is an individual with no geographical limitations.

Born in New York City, he received his elementary schooling in Lenox, Mass. He graduated in 1927 from Harvard College and in 1930 received a doctor's degree from the Harvard Graduate School of Engineering, after specializing in industrial hygiene.

His first work was with the city of Cleveland where he was concerned with the development of filters for cleaning air at high temperatures. He joined the U. S. Public Health Service in 1932 and was with them for nine years. Practically all his work was in the field of industrial hygiene. From 1941-2 Dr. DallaValle was with the New York Department of Labor and the following year with the Kruss Engineering Co., Newark, N. J. At present he is doing research work for the American Air Filter Co., Louisville, Ky During recent years, he has specialized in small particle technology.

The U. S. Public Health Service has published many of his articles including the design of industrial ventilating systems and hood designs.

"The Heat Pump—an all Electric Year-Round Air-Conditioning System" (page 67), is the first of a series of interesting sections or "Blueprints of Post-war Realities." This feature was written by two engineers who are outstanding in the heating and ventilating field.

Philip Sporn, Vice-President and Chief Engineer, American Gas and Electric Service Corp., received his engineering education at Columbia University and joined the company in 1920. He was advanced to chief electrical engineer in 1927, and in 1933 to chief engineer of the parent and associated companies. In 1934 he was elected vice-president in charge of all engineering. With the formation of the American Gas and Electric Service Corp., in 1934, he became vice-president of that company in charge of all engineering activities.

Mr. Sporn is an ardent advocate of the social economic benefits to be derived from the development of the heat pump. After sponsoring the first installation in 1933, he was responsible for the development and installation of such year-round electrically driven air-conditioning systems in 7 office buildings designed and built for subsidiary companies.

Eugene R. Ambrose, co-author, received his B. S. in

mechanical engineering from Carnegie Institute of Technology in 1930. After completing the General Electric test course, he entered the G.E. refrigeration production department as assistant to the supervisor in charge of testing. He became design engineer of ventilating and air-conditioning equipment in 1933, and then was advanced to application engineer.

Since 1939, Mr. Ambrose has been a member of the engineering staff of the American Gas and Electric Service Corp. He is engaged in designing, preparing specifications, and supervising the installation of heating, ventilating and air-conditioning systems for all properties of the company.

George A. Bryant

George A. Bryant, who holds out so much promise for industrial construction (Industrial Construction to Boom, page 49), received an engineering education at the University of Illinois, and joined The Austin Company in 1913 as field engineer. He was advanced to sales manager in 1918 and has served as director since 1922.

Shortly after becoming general manager in 1930, he negotiated the contracts for the design and erection of a $60,000,000 Russian industrial city. Since 1930, Mr. Bryant has had general charge of the design of buildings, making of contracts, and field construction operations. In 1940 he succeeded the late Wilbert J. Austin as president.

His company has designed and built a large number of this country's outstanding aircraft plants and aviation facilities.

There can be no dispute that **Francis William Hutchinson** (Germicidal Aerosols for Post-war Air Conditioning, page 58) is a native California son. Born at Suisun City, he attended the California Institute of Technology where he received his B.S. in 1931. From the University of California he obtained an M.S. in 1937 and an M.E. in 1938. At present he is Assistant Professor of Mechanical Engineering, University of California, Berkeley.

He has been consultant on many heating and air conditioning problems, and has served as mechanical engineer for 7 years with the California & Hawaiian Sugar Refining Corp., San Francisco. He is now traveling in Central and South America.

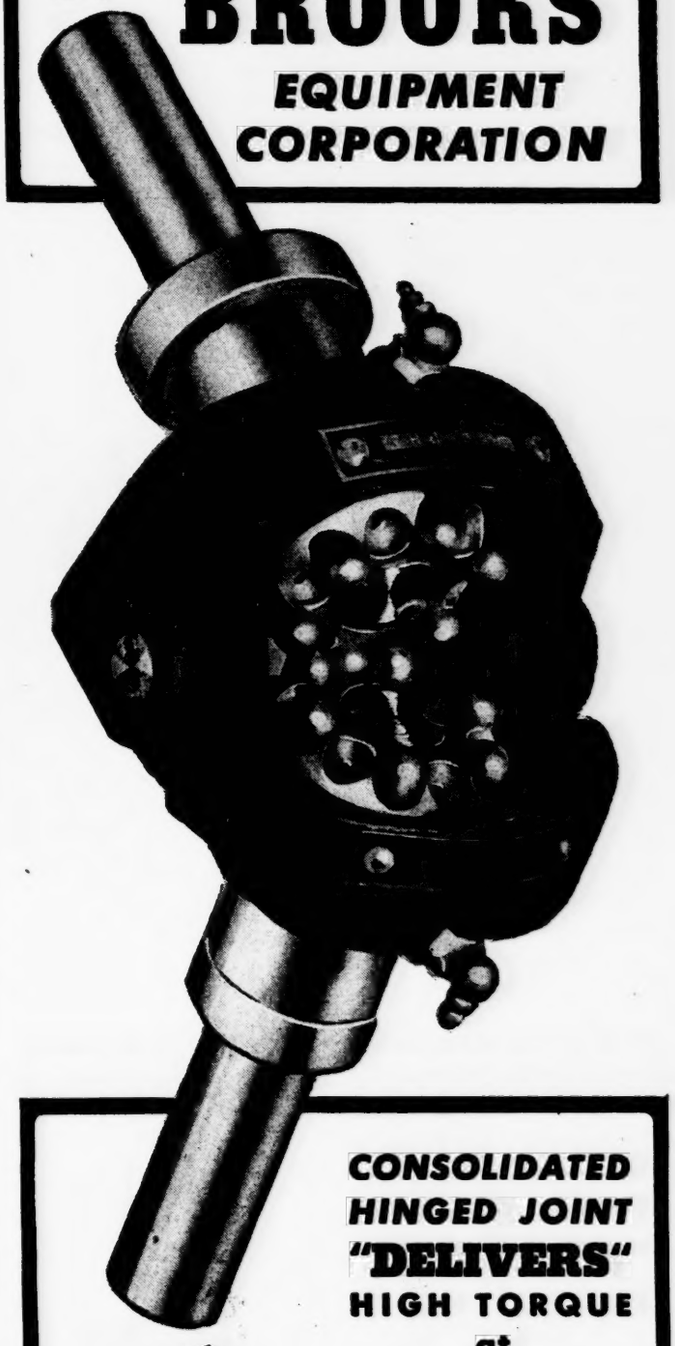
John M. Kane (Collection and Disposal of Magnesium Dust, page 62) is a 1933 mechanical engineering graduate of the University of Kentucky, and ever since graduation has been with the American Air Filter Company, Dust Control Division.

He has presented papers on dust control before several engineering groups, and has written articles on the subject for technical publications.

INDUSTRIAL DEGREE DAYS—November, 1943

City	Number of Industrial Degree Days	
	55F Base	45F Base
Baltimore	246	62
Buffalo	529	262
Chicago	563	272
Cleveland	446	185
Detroit	507	232
Indianapolis	452	190
New York	313	101
Philadelphia	285	82
Pittsburgh	410	162
St. Louis	348	118

BY BROOKS EQUIPMENT CORPORATION



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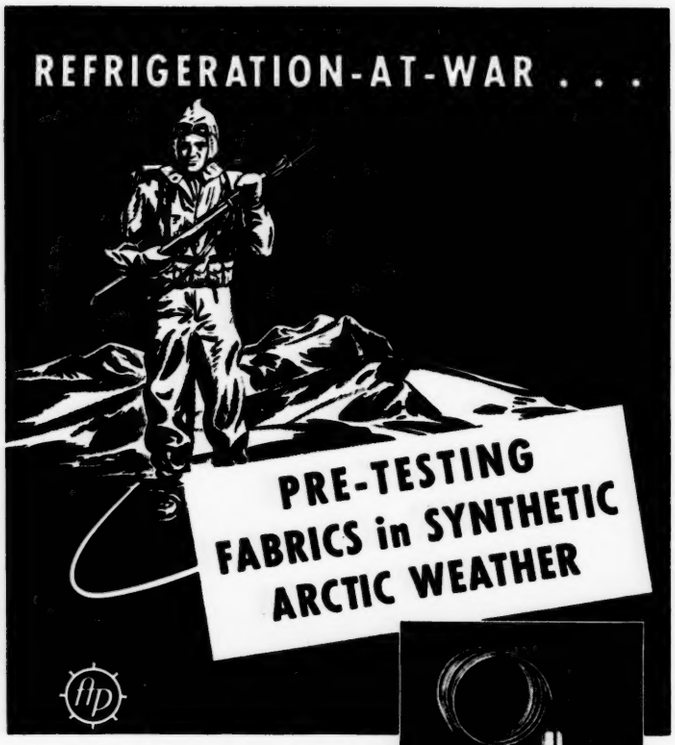

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Thermostatic Expansion—Solenoid—Constant Suction Pressure — Water Regulating—"Trap-Dri" System Protectors — Water Solenoids — Cooling Thermostats.

Model 205 Thermostatic Expansion Valve

• "Synthetic Arctic Weather," refrigerated test chambers for pre-testing combat clothing, fabrics, guns and equipment, is but one of many precision-control applications of A-P Dependable Refrigerant Valves . . . saving time, money, and lives today.

A-P DEPENDABLE Refrigerant Valves are a highly vital part of many of today's refrigeration and air conditioning systems. Their long-established reputation for accurate and dependable refrigerant control, and for smooth, "service-free" operation, is an efficiency that you will want to add to YOUR systems — both on new installations and for replacement purposes. A-P valves are available in all capacities, for Freon, methyl chloride, and sulphur dioxide.

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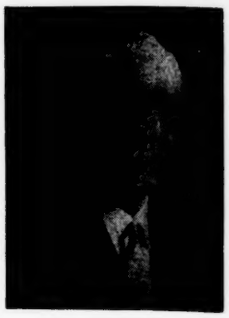

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Born in New York City, he received his elementary schooling in Lenox, Mass. He graduated in 1927 from Harvard College and in 1930 received a doctor's degree from the Harvard Graduate School of Engineering, after specializing in industrial hygiene.

His first work was with the city of Cleveland where he was concerned with the development of filters for cleaning air at high temperatures. He joined the U. S. Public Health Service in 1932 and was with them for nine years. Practically all his work was in the field of industrial hygiene. From 1941-2 Dr. DallaValle was with the New York Department of Labor and the following year with the Kruss Engineering Co., Newark, N. J. At present he is doing research work for the American Air Filter Co., Louisville, Ky During recent years, he has specialized in small particle technology.

The U. S. Public Health Service has published many of his articles including the design of industrial ventilating systems and hood designs.

"The Heat Pump—an all Electric Year-Round Air-Conditioning System" (page 67), is the first of a series of interesting sections or "Blueprints of Post-war Realities." This feature was written by two engineers who are outstanding in the heating and ventilating field.

Philip Sporn, Vice-President and Chief Engineer, American Gas and Electric Service Corp., received his engineering education at Columbia University and joined the company in 1920. He was advanced to chief electrical engineer in 1927, and in 1933 to chief engineer of the parent and associated companies. In 1934 he was elected vice-president in charge of all engineering. With the formation of the American Gas and Electric Service Corp., in 1934, he became vice-president of that company in charge of all engineering activities.

Mr. Sporn is an ardent advocate of the social economic benefits to be derived from the development of the heat pump. After sponsoring the first installation in 1933, he was responsible for the development and installation of such year-round electrically driven air-conditioning systems in 7 office buildings designed and built for subsidiary companies.

Eugene R. Ambrose, co-author, received his B. S. in

mechanical engineering from Carnegie Institute of Technology in 1930. After completing the General Electric test course, he entered the G.E. refrigeration production department as assistant to the supervisor in charge of testing. He became design engineer of ventilating and air-conditioning equipment in 1933, and then was advanced to application engineer.

Since 1939, Mr. Ambrose has been a member of the engineering staff of the American Gas and Electric Service Corp. He is engaged in designing, preparing specifications, and supervising the installation of heating, ventilating and air-conditioning systems for all properties of the company.

George A. Bryant

George A. Bryant, who holds out so much promise for industrial construction (Industrial Construction to Boom, page 49), received an engineering education at the University of Illinois, and joined The Austin Company in 1913 as field engineer. He was advanced to sales manager in 1918 and has served as director since 1922.

Shortly after becoming general manager in 1930, he negotiated the contracts for the design and erection of a $60,000,000 Russian industrial city. Since 1930, Mr. Bryant has had general charge of the design of buildings, making of contracts, and field construction operations. In 1940 he succeeded the late Wilbert J. Austin as president.

His company has designed and built a large number of this country's outstanding aircraft plants and aviation facilities.

There can be no dispute that **Francis William Hutchinson** (Germicidal Aerosols for Post-war Air Conditioning, page 58) is a native California son. Born at Suisun City, he attended the California Institute of Technology where he received his B.S. in 1931. From the University of California he obtained an M.S. in 1937 and an M.E. in 1938. At present he is Assistant Professor of Mechanical Engineering, University of California, Berkeley.

He has been consultant on many heating and air conditioning problems, and has served as mechanical engineer for 7 years with the California & Hawaiian Sugar Refining Corp., San Francisco. He is now traveling in Central and South America.

John M. Kane (Collection and Disposal of Magnesium Dust, page 62) is a 1933 mechanical engineering graduate of the University of Kentucky, and ever since graduation has been with the American Air Filter Company, Dust Control Division.

He has presented papers on dust control before several engineering groups, and has written articles on the subject for technical publications.

INDUSTRIAL DEGREE DAYS—November, 1943

City	Number of Industrial Degree Days	
	55F Base	45F Base
Baltimore	246	62
Buffalo	529	262
Chicago	563	272
Cleveland	446	185
Detroit	507	232
Indianapolis	452	190
New York	313	101
Philadelphia	285	82
Pittsburgh	410	162
St. Louis	348	118

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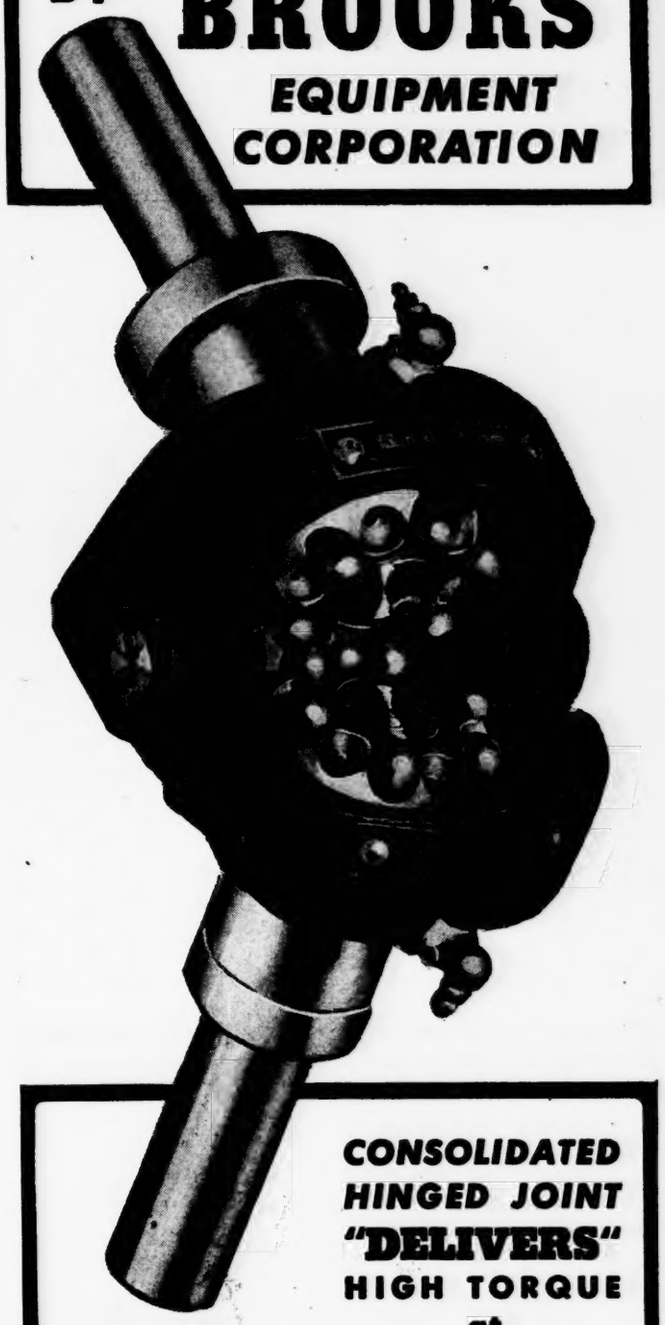

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